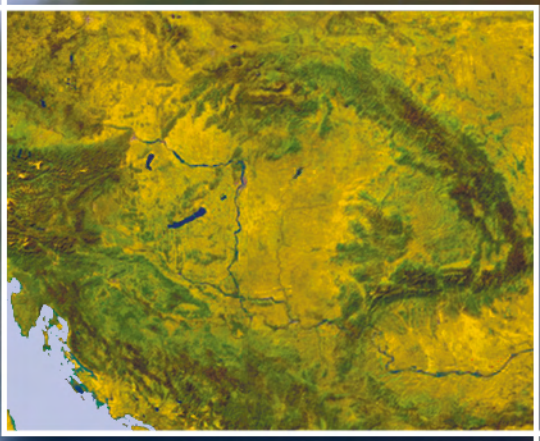
Hungarian Geographical Bulletin



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HUNGARIAN GEOGRAPHICAL BULLETIN 70 2021 (3)

CONTENT

Book review section

River ice and water temperature prediction on the Danube

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Abstract

This paper presents a modification of the theory of weighted mean temperatures for rivers. Rodhe, B. (1952) assumed the dominance of sensible heat transfer on ice formation. We aimed to improve the method for the evaluation of ice and water temperature based on a relatively low number of inputs. We further developed the model by introducing the effect of pre-existing ice, hence increasing the accuracy of the model on the timing of ice disappearance. Prediction accuracy of ±1 day was reached for the timing of the appearance of ice. Additional outputs have also been added to the model, including the termination of ice and the prediction of water temperature. The temperature calculation had a coefficient of determination of 95 percent, and a root mean square error of 1.33 °C during the calibration period without the use of observed water temperatures. The validation was carried out in a forecasting situation, and the results were compared to the energy balance.

Keywords: hydrology; ice dynamics; forecast; water temperature; Danube

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Introduction

River ice development was directly observed on the Danube in January 2017, and the subsequent icy flood was extensively studied on the Tisza in February of the same year. These events highlighted that rivers can still present unexpected challenges in river ice management. A comprehensive report on these events was published by the International Commission for the Protection of the Danube River (Mladenović, B.M. *et al*. 2018). These events are serious threats and may profoundly impact local infrastructure and human life; hence, safe management is not only a priority but also a complex engineering task. Prediction and mitigation of events of this type are priorities and among the main tasks of fluvial hydrology.

The importance of river ice prediction on the Danube was first mentioned by Lászlóffy, W. (1934) for the optimal utilisation of the autumn navigation season. This is still one of the key reasons for river ice prediction because floating ice discs and sheets often reach a thickness of 60 cm and a diameter of 5 metres (Keve, G. 2012). Floating ice of this size may cause severe damage to ships and ferries, not just risking cargo but also threatening the lives of crew members and passengers. Navigation signs may also be damaged or destroyed by ice. Safe navigation of ice-breakers, however, is important, and their deployment has to be planned early enough for cost and time-efficient ice removal. Industrial utilisation such as hydroelectric power generation or cooling-water

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of fossil and nuclear power plants is another key reason for river ice prediction. River ice forecast is closely connected to water temperature forecast due to the environmental regulations of cooling-water outlets. River-related recreation and entertainment services can also rely on water temperature forecasts.

The research site was the Hungarian Danube reach with three selected gauging stations, namely at the settlements of Nagybajcs, Budapest and Paks *(Figure 1).* The study sites are characterised by a semi-humid temperate climate with oceanic (mostly in summer months), continental (mostly in winter months) and Mediterranean influences (Antal, E. 1997; Ács, F. and Bauer, H. 2013). River ice typically occurs between December and early March. The average temperature of the coldest month (January) is around 0 °C. The number of frost days (daily minimum temperature < 0 °C) and the number of winter days (daily maximum temperature < 0 °C) reflects the local ice generation potential of winter seasons. Several studies on the long-term evaluation of the number of frost days are available (Antal, E. 1997; Szalai, S. and Szentimrey, T. 2005; Bihari, Z. 2018) that indicate a slight decrement of 0.14 days/year. The number of frost and winter days shows a wide variation across the country with an average of 90 to 100 frost days and 20 to 30 winter days along the Danube (Bihari, Z. 2018).

Most of the water temperature models are either deterministic or statistical (Benyahya, L. *et al.* 2007). Deterministic models are mathematical representations of the physical processes, generally based on the energy balance approach. They require a great number of input data, but they are efficient tools for analysing the components of heat flux. Statistical models are classified into either parametric (regression and stochastic models) and non-parametric models (machine learning, artificial neural networks).

Westhoff, M. *et al.* (2007) published results of a detailed energy balance and temperature transport model on sub-catchments of the Maisbich catchment (Luxemburg). A small stream of approximately 600 m length with an average discharge of 1.21 l/s during the

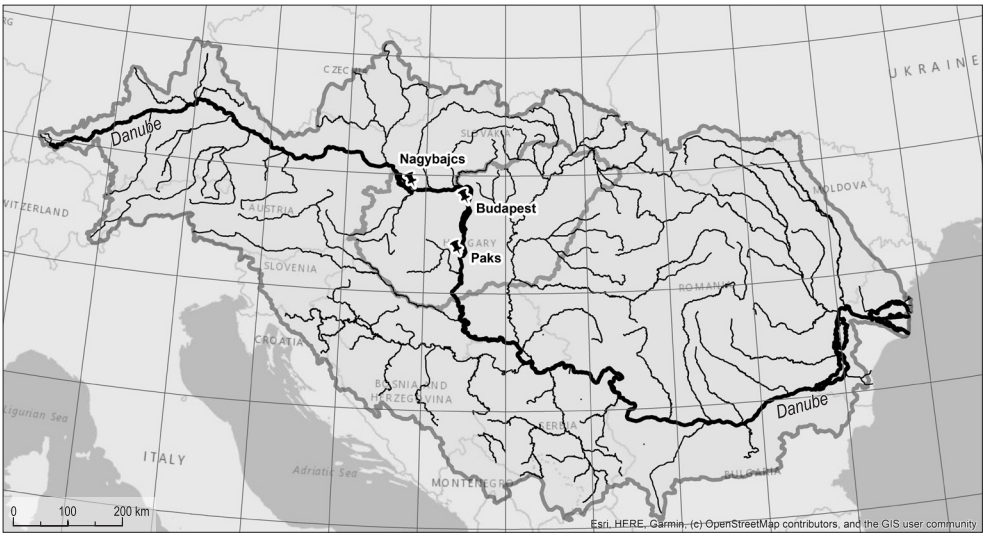


Fig. 1. Locations of the three selected stations in the Danube catchment

observations was analysed. High-resolution temperature measurements were compared to the simulated results in order to identify the quantity and location of groundwater sources. The Root Mean Square Error (RMSE) of the model was only 1.01 °C.

The results of statistical water temperature modelling were published by Ahmadi-Nedushan, B. *et al.* (2007) on the Canadian Moisie River (annual mean discharge of 466 m^3/s). A sinusoidal annual component was estimated with the annual RMSE from 1.66 °C to 2.21 °C for the calibration period, and residual short-term variations were implemented by additional models of 4 to 9 parameters. The presented RMSE ranged from 0.502 °C (9 variables) to 0.511 °C (4 variables) during calibration and from 0.521 °C (5 variables) to 0.533 °C (6 variables) on validation.

A large-scale study was presented by van Vliet, M.T.H. *et al.* (2012) on the modelling of streamflow and water temperature on catchments of several hundreds of thousands of km^2, including the Danube. The authors used a grid-based hydrological routing model coupled with a one-dimensional stream temperature model with daily time-step over a period of more than 20 years. Observations from 13 stations were compared to simulated water temperatures on the Danube, and the average RMSE of 2.5 °C was achieved.

Certain components of the deterministic models are often derived from empirical relations, *but there are also models that are physically-based only on sensible heat transfer* but either completely neglect other terms or use conceptual and experimental additions to imitate the behaviour of the full energy balance. Toffolon, M. and Piccolroaz, S. (2015) published a hybrid model called *air2stream*, defining water temperature as a function of air temperature, discharge and a sinusoidal function for fictitious lateral inflows and heat fluxes. They selected three rivers in Switzerland with different hydrological conditions: the Mentue for a natural lowland type, the Rhτne at Sion for a regulated type, and the Dischmabach for a snowmelt-fed type. The largest among the three is the Rhτne with an annual average discharge barely above 100 m^3/s at the city of Sion. However, besides its large number of input parameter requirements, high uncertainty of the heat fluxes was associated with the model. The RMSE values ranged from 0.58 °C (8 input parameters) to 0.91 °C (3 parameters) on calibration, and from 0.62 °C (8 parameters) to 1.05 °C (both 5 and 3 parameters) on validation. The model performance on the Rhτne was the least efficient, Nash-Sutcliff model efficiency coefficient (NSE, Nash, J.E. and Sutcliffe, I.V. 1970) were 0.89 for 8 and 7 parameters and 0.79 for 5, 4 and 3 parameters.

An ensemble approach of water temperature forecast was published by Ouellet-Proulx, S. *et al.* (2017). They modelled two Canadian catchments, the regulated Nechako (discharge regulated between 170–283 m^3/s) and natural Southwest Miramichi Rivers (mean discharge is 120 m^3/s at the selected station). Their method was based on a semi-distributed rainfall-runoff model called CEQUEAU and the estimation of energy balance terms at each grid cells. The RMSE values of the operational forecast system ranged from 0.81 °C on day 1 to 1.48 °C on day 3 based on an autoregressive model. The parameters of the thermal model were calibrated to get the best model performance over the summer period since the main target of their water temperature forecast was to minimise the exposure of aquatic organisms to high water temperature. RMSE values of 0.78 °C on Nechako and 1.23 °C on Miramichi were achieved during calibration on summer period, while 0.95 °C and 1.46 °C during validation. The year-round comparison resulted in 1.38 °C on Nechako and 1.37 °C on Miramichi for calibration and 1.54 °C and 1.51 °C for validation.

Comparisons of six statistical models were carried out by Zhu, S. *et al.* (2018) on the Missouri River ($Q_{mean} \approx 4{,}500$ m^3/s) at three stations: three regression-based parametric models with linear, non-linear and stochastic expressions, and three machine learning procedures (artificial neural networks, Gaussian process regression, Bootstrap ag-

gregated decision trees). Poor performance of linear and non-linear regression was found, RMSE values ranged from 2.99 °C to 3.94 °C. The stochastic model performed better, RMSE values ranged from 1.72 °C to 2.14 °C. Machine learning procedures all performed better, their RMSE ranged from 1.4950 °C to 1.9784 °C. An earlier study on the Missouri is available from Zhang, Z. and Johnson, B.E. (2017), where they applied the temperature transport of HEC-RAS (Hydrologic Engineering Center – River Analysis System) but observed data were heavily limited. RMSE values of the HEC-RAS simulation are not published, but the RMSE values of linear regression at boundary conditions are published from 1.744 °C to 3.532 °C.

Tavares, A. *et al.* (2018) applied the model proposed by Toffolon, M. and Piccolroaz, S. (2015) on the river Cebollati, Uruguay (Q_{mean} ≈ 1,377 m^3/s at Lagoon Mirim) using water temperature derived from remote sensing (Landsat and MODIS) data. The RMSE of 1.296 K during calibration and 1.245 K were achieved.

Piotrowski, A.P. and Napiorkowski, J.J. (2018) aimed to find an effective calibration method for *air2stream* model. They compared twelve different calibration algorithms on six different streams of lowland, hilly and mountainous types with catchment size under 1,000 km^2 (Q_{mean} < 10 m^3/s in each case). A comparison was also done with classical data-driven models, namely the multiple linear regression, the Mohseni, O. *et al.* (1998) four-parameter model and its modified version by van Vliet, M.T.H. *et al.* (2011) with five parameters. The *air2stream* model produced an RMSE of 1.123 °C for calibration and 0.909 on validation for the largest river but also indicated a strong dependency on the optimisation method.

Zhu, S. *et al.* (2019) published a comparison of three machine learning methods (feedforward neural network, Gaussian process regression and decision tree) and the 8, 5 and 3 parameter version of *air2stream* model on seven rivers. One of the rivers studied was the Drava with two selected gauging stations at Botovo and Donji Miholjac (Q_{mean} ≈ 500 m^3/s). An almost identical calibration RMSE was obtained for the two stations: 0.876, 1.002, 1.046 °C at Botovo and 0.876, 0.959, 0.955 °C at Donji Miholjac with 8, 5 and 3 parameters. Validation RMSE values showed a greater difference: 0.891, 1.000, 1.006 °C at Botovo and 1.247, 1.310, 1.370 °C at Donji Miholjac. Their results showed that *air2stream* models generally outperform machine learning methods.

Numerous river ice prediction techniques and models have been developed and analysed in recent years. These approaches include statistical models such as the cumulative negative air temperature degree-days published by Graf, R. and Tomczyk, A.M. (2018), analytical formulations such as RICE (Lal, W.A.M. and Shen, H.T. 1991) and RIVICE (Lindenschmidt, K-E. 2017) coupled with one-dimensional river hydraulics, and the two-dimensional DynaRICE (Kolerski, T. 2018). These models are capable of simulating small-scale dynamic river ice processes, but they require geometrical (digital terrain model for 2D, cross-sections for 1D) and hydrological (water levels and discharges for initial and boundary conditions) data for hydraulic simulations and data due to the deterministic approach on heat flux. Comparative testing of such models was also carried out by Carson, R. *et al.* (2011).

The above overview highlights that there are several methods tested and published for water temperature simulation, but their performance is highly dependent on the number of variables. Furthermore, the large number of variables makes the calibration procedure unavoidable. Findings also show a decreasing performance with increasing annual flow. In this paper, we aim to introduce a conceptual method with lumped parameters and minor data requirements, which at the same time provides satisfactory results on the Danube river. Such a model is highly flexible, easy to apply on rivers of similar characteristics and quickly provides results for decision-makers, stakeholders and operational application managers.

Materials and methods

We chose the theory of weighted mean temperatures (Rodhe, B. 1952, 1955) as a basis. The theory, published by the Swedish meteorologist Bertil Rodhe in 1952 and later in 1955, was an answer to the uncertain approach of temperature sum based methods (Östman, C.J. 1950; Nusser, F. 1950; Palosuo, E. 1951) of that era. This approach was specifically developed for marine application, but the U.S. Army Cold Regions Research and Engineering Laboratory experimented with river application (Bilello, M.E. 1963) and also recommended further testing.

Rhode assumed that all terms of the full energy balance are neglected but the direct energy transfer between water and air. The governing equation (1) is based on heat transfer which is induced on the boundary of water and air of different temperatures. Following Rodhe's derivation from the Newtonian law of heat transfer and the equation of temperature change of water due to this transfer, we get to the continuous form of the basic equation:

$$\frac{d\tau}{dt} = k(T - \tau), \quad (1)$$

where T is the air temperature (°C), τ is the water temperature (°C), t is the time (s), and k is the time inverse coefficient (1/s) or a constant with an inverse dimension of time (Rodhe, B. 1952, 1955; Bilello, M.E. 1963). The equation simply describes the change of water temperature as a proportion of the difference of water and air temperatures, where the rate is symbolised with a time inverse coefficient. From the derivation, it is clear that the physical content of the k constant is the summation of all the material parameters of heat exchange:

$$k = \frac{\alpha}{c\gamma h\rho}, \quad (2)$$

where k is the time inverse coefficient (1/s), α is the heat transfer coefficient (W/m²/°C)], c is the specific heat of water (J/kg/°C), h is the depth of heat exchanging water layer (m), γ is the ratio of the change in surface temperature and the change in the mean temperature of the heat exchanging subsurface layer ($0 < \gamma < 1$), and ρ is the density of water (kg/m³). After the solution and discretisation of the basic differential equation (1), the final form is equation 3.

$$\tau_n = \tau_{n-1} + (1 - e^{-k\Delta t})(T_n - \tau_{n-1}), \quad (3)$$

where T_n is the average air temperature at a time step t_{n-1}-t_n (°C), τ_n is the temperature of the water surface at t_n (°C), τ_{n-1} is the temperature of the water surface at t_{n-1} (°C), Δt is time step (s) and k is a constant with an inverse dimension of time (1/s).

Since the method was developed for the prediction of the onset of ice formation, the free variable k should be selected in such a way that the series of τ reached a freezing point when the first patch of ice was observed. Promising results were obtained by applying the method on the Danube river in Hungary on the ice events from 2008 to 2017 (Liptay, Z.Á. 2018).

During the process of adaptation, we focused on empirical approaches for maximising the efficiency of the method while conserving its modest need for data and computational capacity. The first step of adaptation was to introduce the ability to predict the disappearance of ice. By dividing the lag parameter with different values at sub-zero temperatures then at above freezing the method becomes capable to simulate this phenomenon. We simplified this to a ratio of the original lag value, therefore only one new variable was introduced.

$$k = \begin{cases} k & \text{if } \tau_{n-1} > 0 \\ k \cdot r & \text{if } \tau_{n-1} < 0 \text{ and } (T_n - \tau_{n-1}) < 0 \\ \frac{k}{r} & \text{if } \tau_{n-1} < 0 \text{ and } (T_n - \tau_{n-1}) > 0 \end{cases} \quad (4)$$

where r is the correction of k when the τ function is negative [-] ($1 < r$).

The second adaptation step was to estimate the evolution of water temperature. We calibrated the parameters towards water temperature and obtained a close correlation between the τ *series* and observed water temperatures.

A difference in the temperature gradients was found at 4 °C, comparing the observed and calculated water temperatures. The τ series calibrated for water temperature calculation continues to react intensively for further cooling; however, observed water temperatures show only moderate changes. Mohseni, O. and Stefan, H.G. (1999) analysed the relationship between water temperature and air temperature based on physical interpretation and defined four ranges:

1) air temperature is under -10 °C, and the equilibrium water temperature is around 0 °C;

2) air temperature is between -10 and 0 °C while stream temperature is above 0 °C and increased significantly with air temperature, but the slope of their relationship is defined by groundwater;

3) air temperature is between 0 and 20 °C, and water temperature tends to change linearly with air temperature;

4) high air temperatures, and water temperature rises slowly with air temperature.

These ranges resemble an S-shaped relation of water temperatures and air temperatures. *Figure 2* shows the relation of weekly water temperature and air temperature measures at the Budapest gauging station from 2008 to 2017. The S-shaped relation is clearly visible, and while both linear and polynomial regressions have high and nearly equal r^2 over the entire set of data, linear regression shows poor performance in Ranges 2 and 4.

As a result, we divided the lag value into two parts at the arbitrarily selected 4 °C threshold to follow this relation:

$$k = \begin{cases} k & \text{if } \tau_{n-1} > 4 \\ k_{below\ 4\ °C} & \text{if } \tau_{n-1} < 4, \text{ and } \tau_{n-1} > 0 \\ k \cdot r & \text{if } \tau_{n-1} < 0 \text{ and } (T_n - \tau_{n-1}) < 0 \\ \frac{k}{r} & \text{if } \tau_{n-1} < 0 \text{ and } (T_n - \tau_{n-1}) > 0 \end{cases} \quad (5)$$

An example is presented in *Figure 3*. The first parameterisation (Rodhe 1/k = 10 days) adequately reproduces the observed water temperatures but gives an erroneous ice prediction. The second parameterisation (Rodhe 1/k = 17.7 days) scheme gives an accurate ice prediction but overestimates water temperatures. A combination of the two (Rodhe combined) gives a method applicable to both situations.

As a third adaptation step, we assumed that water temperature calculated at t_n is not only the function of water temperature at t_{n-1} and the mean temperature of the station but also the mean temperature of the upstream station at t_{n-m}, where m is the distance of the stations in time.

$$T_n = z \times T_{n,local} + (1 - z) T_{n-m,upstream}, \quad (6)$$

where T_n is the resulting daily mean air temperature at time step t_{n-1}-tn (°C), $T_{n,\ local}$ is the

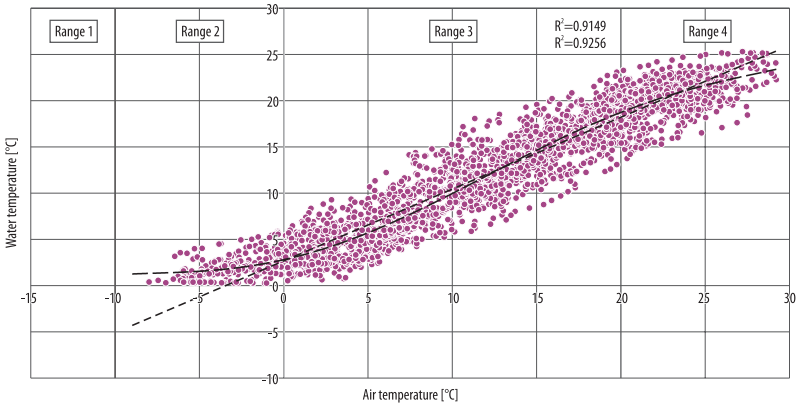


Fig. 2. Relation of weekly water temperature and air temperature on the Danube at Budapest

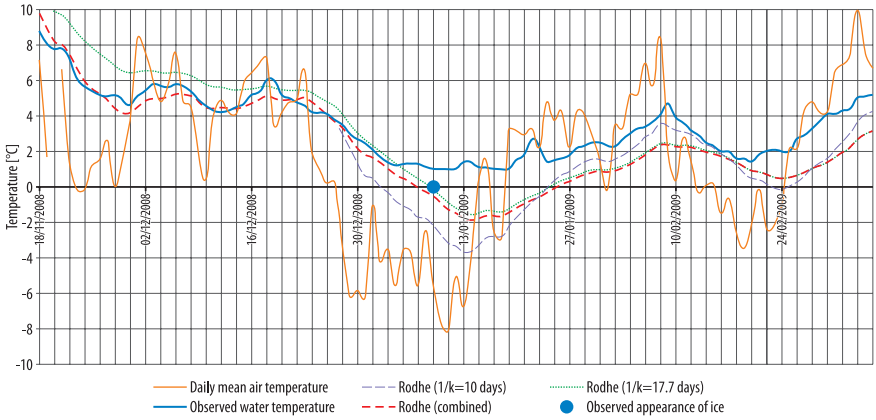


Fig. 3. The combination of water temperature and ice forecast

local daily mean temperature (°C), $T_{n\text{-}m,upstream}$ is the daily mean air temperature at the upstream station (°C), z is a factor dependent on flow regime [-].

$$z = 1 - (MT_n \times s), \tag{7}$$

where z is a factor dependent on flow regime [-], MT_n is the daily value of flow regime (%), s is a calibration parameter [-]. The value of z should be chosen to simulate the local impact during low flow and the increasing weight of upstream impact with the rising water level. The daily flow values were derived from the observed water levels in the hindcast period and from predicted water levels in the forecast period.

Upscaling and positioning the aforementioned methods to a new perspective of complex hydrological networks, the influence of tributaries is a key factor on ice formation and dynamics. By analysing the ice event of January 2017 on the Danube river, the influence of the Váh river is evident on the ice formation of the main stream. Satellite images, acquired by for instance, the Sentinel-2A satellite at a spatial resolution of 10×10 metres, may also provide important information on riverine ice dynamics. For the current study, Sentinel-acquired satellite imagery taken on 8 January was used *(Figure 4).*

The light coloured pixels of floating ice sheets were easily recognisable without any further image analysis; however, an averaging of bands was done to obtain a grayscale version. There were no drifting ice formations upstream of the junction, whereas drifting ice was observable on the Váh river. The ice sheets floated along the left bank following their arrival into the confluence with the Danube. Subsequently, using the available ice forming potential of the Danube, the ice cover broadened and covered the entire water surface on the right side of the image near the town of Almásfüzitő. It is challenging to explain this phenomenon with the theory of weighted mean temperatures; hence, we assumed that the selected set of parameters explain the general ice dynamics.

Results and discussion

Calculations with the original and the modified Rhode method were carried out for the period of 1 July 2008 to 31 August 2017. The initial conditions were the monthly average air temperatures of June 2008 in each case. Four ice cover events (2008–2009, 2009–2010, 2011–2012 and 2016–2017) occurred in this period. The first event was used solely for

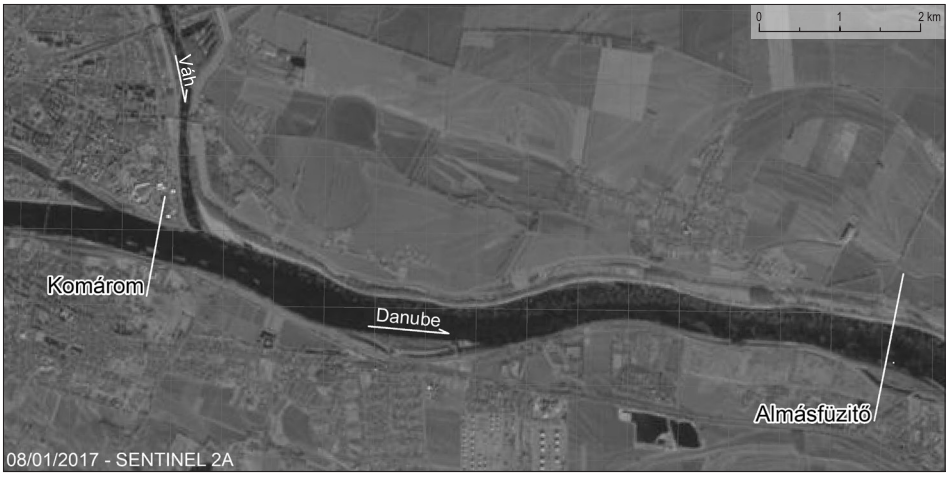


Fig. 4. Sentinel-2A image, 08.01.2017.

calibration purposes at each station, whereas the other three events were for validation. The values of lag and the later introduced parameters of equations (5) and (7) were calibrated using a trial-and-error approach with the target functions to minimise the RMSE and hit the day the ice run started and ended. Nagybajcs station is downstream of Gabčikovo reservoir (Slovakia); thus, the outflow from the reservoir heavily influences the water temperatures and ice formation resulting in only two observed ice events in 2011–2012 and 2016–2017. According to Mohseni and Stefan (1999) Range 1 and Range 2 of the water temperature and air temperature relation are influenced by the artificial upstream water temperature.

Table 1 includes the results of the prediction of ice appearance and disappearance with both the modified and original methods in brackets. A zero value means an exact match with observations; a negative value refers to ice predicted prior to the observed onset of icing; and a positive value means that ice was predicted later than the actual timing (all units are in days).

The last two rows of *Table 1* indicate the efficiency of water temperature calculation of the modified method, namely the root mean square error and the determination coefficient. The ice appearance prediction efficiency of the original method in our case was between +2 and -2 days, and two out of the seven validation dates were precisely given. After the implementation of the modifications, this efficiency increased to ±1 day, and three out of the seven validation dates were precisely simulated by the model. The original method did not provide usable results regarding the disappearance of the ice, but after the modification, the validation succeeded, with only one icy period (2009–2010) being a major error. The RMSE and r^2 values of water temperature simulation of 1.46 °C and 93.3 percent were achieved at the Nagybajcs gauging station during the calibration. This station is the most upstream station, meaning equation (6) is not applicable. The RMSE and r^2 values at Budapest were 1.19 °C and 96.3 percent, while 1.32 °C and 95.7 percent at Paks, respectively.

The most recent heavy icy event on the Danube was observed in January and February 2017 *(Figure 5).* After an abrupt drop in air temperature, a thick layer of ice cover was formed on the river covering more than 80 percent of the river surface at Budapest on 8 January 2017. The modified algorithm

Table 1. Validation results on ice occurrence and disappearance prediction efficiency on the Danube and correlation of observed and calculated water temperatures*

Ice observation period	Ice prediction error, days		
	Nagybajcs, 1,801.0 rkm	Budapest, 1,646.5 rkm	Paks, 1,531.3 rkm
2008–2009	–	calibration	calibration
2009–2010	–	0; 7 (0; 15)	-1; 9 (-1; 15)
2011–2012	calibration	1; 1 (-2; 11)	-1; 1 (-2; 12)
2016–2017	-1; 0 (2; 0)	0; 0 (-1; 19)	0; -1 (0; 18)
Correlation of observed and calculated water temperature			
RMSE, calib./valid., °C	1.46 / 1.80	1,19 / 1.17	1,32 / 1.22
r^2, calib./valid., %	93.3 / 92.8	96.2 / 97.5	95.7 / 97.3

*Results with the original method of Rodhe, B. (1952) are in brackets.

exactly hit the day that the ice run started and the day it finally stopped, and it also represented the dynamics, a clear advancement from the original method *(Figure 6)*.

The calibration of the water temperature simulations was carried out for the entire study period, while the validation was only done for the period of 1 July 2017 to 30 June 2018. The RMSE and r^2 are presented in *Table 1.* Validation RMSE at Nagybajcs station was 1.80 °C, a slightly lower efficiency was obtained by the calibration. The RMSE of validation reached 1.17 °C and 1.22 °C at Budapest and Paks, respectively. The reason for better performance during the validation is assumed to be the ice-free period chosen for validation when water temperature remained mainly in Ranges 3 and 4.

Further analyses were also done by simulating operative forecast and providing ECMWF temperature predictions as input. We compared the results to the estimation of energy balance (EEB) at Paks station. The RMSE values for the calibration period between 2010 and 2017 based on observed and forecasted water temperature values are presented in *Figure 7*. The initial condition of the energy balance was the latest observed water temperature, while the results of the modified Rodhe method were corrected with

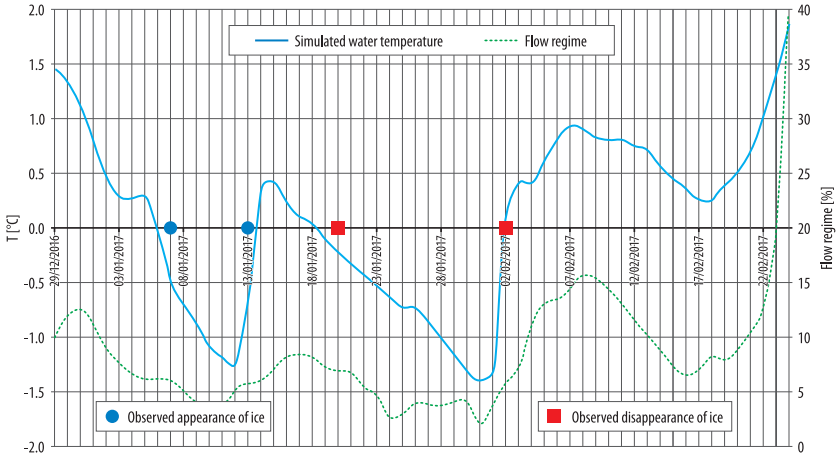


Fig. 5. Ice event in January 2017 at Budapest on the Danube compared to the results of the modified Rodhe method

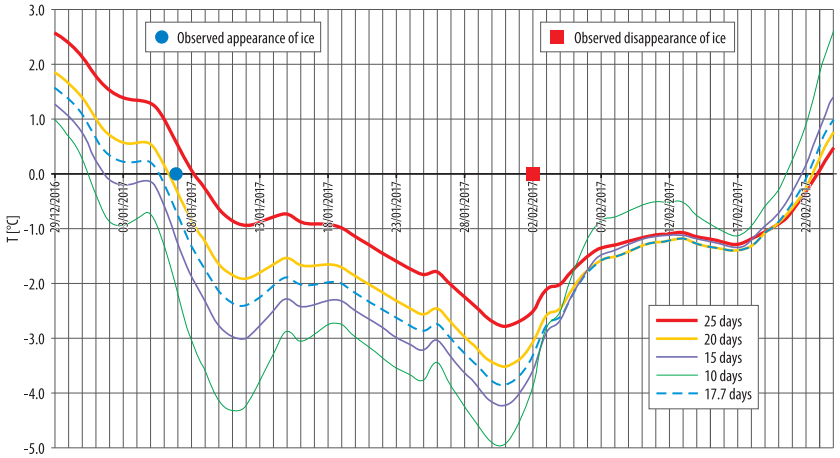
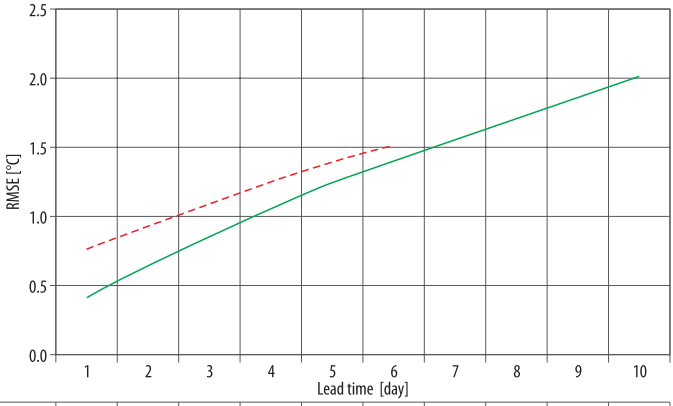


Fig. 6. Ice event in January 2017 at Budapest on the Danube compared to original Rodhe method with different lag time values



E.E.B. (published forecast)	0.76	0.93	1.09	1.25	1.39	1.51				
mod. Rhode with correction	0.41	0.65	0.86	1.06	1.24	1.40	1.55	1.71	1.86	2.01

Fig. 7. RMSE values of water temperature forecast based on the estimation of energy balance (EEB) and the modified Rhode method from 2010 to 2017 on the Danube at Paks.

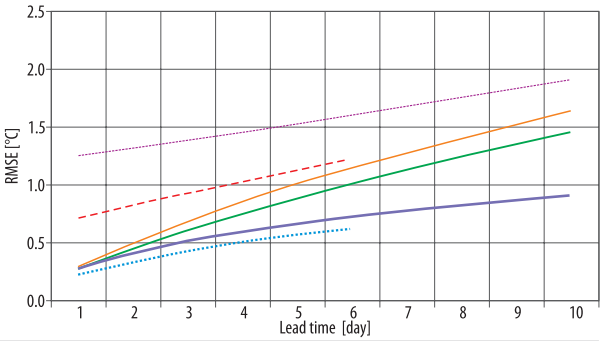
the error on the day of the forecast, and both of the calculations were driven by the daily mean air temperature derived from ECMWF meteorological forecast of the exact day. The correction technique was a simple deduction of error of the day of forecast.

The ECMWF based analysis was also done for the validation period. RMSE values are listed in *Table 2* for all three stations, while *Figure 8* presents the comparison of the results at Paks with archived published six forecasts:

– No. 1 presents the result with the modified Rodhe method without taking into account water temperature observations.
– No. 2 shows the result with the modified Rodhe method without hindcast but started from the observed value at the time of forecast.

Table 2. RMSE (°C) of water temperature forecast based on ECMWF temperature prediction in the validation period 01.07.2017–30.06.2018

	Lead time, day									
Station	1	2	3	4	5	6	7	8	9	10
Nagybajcs	1.91	2.02	2.13	2.25	2.34	2.41	2.49	2.58	2.68	2.77
Budapest	1.20	1.22	1.31	1.41	1.50	1.59	1.68	1.76	1.85	1.92
Paks	1.25	1.32	1.38	1.46	1.53	1.61	1.68	1.75	1.84	1.92



(1) mod. Rhode	1.25	1.32	1.38	1.46	1.53	1.61	1.68	1.75	1.84	1.92
(2) mod. Rhode from observation	0.29	0.50	0.68	0.85	1.01	1.15	1.28	1.40	1.53	1.64
(3) mod. Rhode with correction	0.27	0.45	0.61	0.75	0.89	1.01	1.13	1.24	1.36	1.46
(4) mod. Rhode with correction (observed air temperature only)	0.27	0.42	0.52	0.60	0.67	0.73	0.78	0.83	0.87	0.91
(5) old E.E.B. (published forecast)	0.72	0.83	0.93	1.03	1.14	1.23				
(6) advanced E.E.B. (observed air temperatures only)	0.23	0.33	0.43	0.51	0.57	0.62				

Fig. 8. RMSE values of water temperature forecast based on the estimation of energy balance (EEB) and the modified Rhode method with and without correction from 01/07/2017 to 30/06/2018 on the Danube at Paks.

– No. 3 is similar to no. 1, but the predicted water temperatures are corrected with the error measured on the day of the forecast. This approach provides the best results regarding the RMSE of the water temperature forecast.
– No. 4 shows the results with the modified Rhode method after the correction with the error measured at the time of forecast, similarly to Series no. 3. The difference is that the mean air temperature values are not from ECMWF forecasts, but directly from the averaging of hourly observations. The difference between Series no. 3 and 4 indicates the uncertainty introduced by the meteorological forecast.
– No. 5 shows the published water temperature forecasts of this period calculated by the estimated energy balance based on ECMWF temperature forecasts.
– No. 6 presents the results of an ongoing update of the estimated energy balance based method. This update includes the recalibration of parameters on the period of 1 July 2015 to 30 June 2017 and validation from 1 July 2017 to 30 June 2018 and also includes the introduction of a new approach for the estimation of the albedo of water surface compared to the previously used constant value. The input for this calculation was purely observed data, and no ECMWF forecasts were included.

Conclusions

We found the weighted mean temperatures model of Rodhe, B. (1952) applicable for the simulation of ice dynamics on the Danube

Table 3. Comparison of water temperature modelling results with other published studies

Author	Model class	Name of river	Annual mean discharge of studied rivers, m^3/s	RMSE of calibration, °C	RMSE of validation, °C
Ahmadi-Nedushan, B. *et al.* (2007)	Statistical (parametric)	Moisie	466	0.502–0.511	0.521–0.533
Westhoff, M. *et al.* (2007)	Deterministic (physical)	Maisbich	0.00121*	1.01	-
van Vliet, M.T.H. *et al.* (2012)	Deterministic (physical)	Danube	13 stations**	2.5	-
Toffolon, M. and Piccolroaz, S. (2015)	Deterministic (hybrid)	Mentue, Dismabach and Rhtne	1.7–112.0	0.58–0.91	0.62–1.05
Ouellet-Proulx, S. *et al.* (2017)	Deterministic (physical, ensemble)	Nechako and Miramichi	120–283	0.78–1.23 (summer) 1.37–1.38 (year-round)	0.95–1.46 (summer) 1.51–1.54 (year-round)
Zhang, Z. and Johnson, B.E. (2017)	Statistical (parametric)	Missouri	4,500	1.744–3.532	-
Zhu, S. *et al.* (2018)	Statistical (parametric)	Missouri	4,500	1.72–3.94	-
Zhu, S. *et al.* (2018)	Statistical (non-parametric)	Missouri	4,500	1.4950-1.9784	-
Tavares, M.H. *et al.* (2018)	Deterministic (hybrid)	Cebollati	1,377	1.296 (published in K)	1.245 (published in K)
Piotrowski, A.P. and Napiorkowski, J.J. (2018)	Deterministic (hybrid)	Biala Tarnowska	9.5	1.123	0.909
Zhu, S. *et al.* (2019)	Statistical (non-parametric)	Drava	500	0.956–2.584	1.302–2.732
Zhu, S. *et al.* (2019)	Deterministic (hybrid)	Drava	500	0.876–1.046	0.891–1.370
Current research	Deterministic (conceptual)	Danube	Nagybajcs: 1,830 Budapest: 2,238 Paks: 2,324	1.46 1.19 1.32	1.80 1.17 1.22

*Average during observation. ** E.g. Passau 580; Vienna 1,900; Budapest 2,238; Belgrade 4,000.

at the three selected stations. We further refined the model for increased accuracy on the temporal dynamics of ice cover. The original equation predicted ice cover for ice-free periods and predicted icy periods with an accuracy of ±2 days. (Liptay, Z. Á. 2018).

The empirically based modifications affected the results positively and strengthened the validity in the study area. A precision comparable to the estimated energy balance method was achieved based on the theory of weighted mean temperatures with a simple algorithm and fewer parameters.

Findings of five statistically and seven deterministically based former studies indicate that water temperature modelling is generally less efficient on larger rivers (Benyahya, L. *et al*. 2007; Westhoff, M. *et al*. 2007) *(Table 3).*

While the RMSEs ranged between 0.5 °C and 1 °C for a river of Q_{mean} < 500 m³/s for both deterministic and statistic models, they increase to the range of 1–4 °C for larger rivers. The proposed model of the current study is in the middle of the list regarding the RMSEs if flow values are disregarded but shows superior performance for rivers with nearly equal or higher discharge and performs better than any other model used for the Danube. The number of free parameters for water temperature calculation is four in the present study, namely the two lag (*1/k*) values above 0 °C and the calibration variable (*s*) for flow regime, with another variable (*r*) being introduced during ice formation. Toffolon and Piccolroaz (2015) presented a 3-parameter version of the *air2stream* model, also applied by Zhu, S. *et al.* (2019), but its performance is poor compared to the very well performing 8-parameter version. Nonetheless, the large number of parameters is the price for simplicity and comes with significant dependence on the calibration method (Piotrowski, A.P. and Napiorkowski, J.J. 2018).

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Assessment of climate change exposure of tourism in Hungary using observations and regional climate model data

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Abstract

Climate constitutes key resources for tourism since it influences the range of tourism activities and the development of tourism supply. Tourism is highly sensitive to changes in climate elements. It is extremely important for adaptation strategy-making to explore whether the tourism climate conditions in a given region and at a specific time are appropriate and how they may change in the future. This is described by the exposure of the tourism sector to climate conditions and climate change. In this study, we analyse the exposure of tourism for Hungary on a district level and every month (from March to November) with the help of the modified Tourism Climate Index. First, the present conditions are evaluated based on a gridded observational database CarpatClim-HU, which forms the basis for assessing the future conditions. Afterwards, the expected future circumstances are analysed using regional climate model outputs. In order to interpret the uncertainties of the climate projections properly, we use two different model results (HIRHAM5 and RACMO22E) relying on two emission scenarios (RCP4.5 and RCP8.5). The results have demonstrated that the most favourable conditions are found in spring (MAM) and autumn (SON), while in summer (JJA) a decline in climate potential is observed. According to the future tendencies, generally, a decline is expected between May and September, but the other investigated months usually bring an improvement. For a given emission scenario, the expected trend is quite similar for the two model experiments, while for a given climate model, the use of RCP8.5 scenario indicates larger changes than RCP4.5. The results prove that climate change will have an obvious impact on tourism potential in Hungary, and therefore tourism strategy development has to take into account this effect more than before.

Keywords: climate change, climate exposure, tourism, regional climate model, modified Tourism Climate Index, districts of Hungary

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Introduction

Tourism is one of the most important and dynamically developing sectors of the global and Hungarian economy. Weather and climate are key resources for tourism, and in certain cases they serve as tourist attractions (Perry, A.H. 1997; Gómez Martín, B. 2005). The complex interactions between atmospheric climate elements influence the development of tourism supply, sometimes limiting tourism activities or on occasion encouraging the development of alternative tourism products. The climatic conditions of a given destination can provide substantial motivation to visit the site (Lohmann, M. and Kaim, E. 1999; Kozak, M. 2002) and play a key role in the decision-making processes of destination selection (Hamilton, J.M. and Lau, M.A. 2005; Scott, D. and Lemieux, C. 2010).

Observations from recent decades have shown that climate change has an impact on natural and human systems around the world. Tourism is one of the economic sec-

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tors that is most exposed and sensitive to environmental change, including climate change (UNWTO 2008; Scott, D. *et al.* 2012).

Climate change has direct and indirect impacts on tourist destinations and the tourism industry (UNWTO 2008). Indirect effects include sea-level rise, changes in biodiversity, an increase in the frequency of extreme weather events, changes in snowfall or heat load, among others. They have a significant negative impact on several areas, including tourism infrastructure, time of travel, tourism activity, water resources, ecotourism and epidemics. The direct effects can be identified by the modification of the different climate parameters (averages, extremes) due to climate change. As a result, climate change can alter the global or regional spatial and temporal distribution of climate resources, resulting in a change in international or domestic tourism flows in space and time (Amelung, B. and Moreno, A. 2012; Rutty, M. and Scott, D. 2014). As another direct effect, climate change negatively affects many outdoor activities that are important for tourism through extreme weather events.

One of the key factors for sustainable tourism development is to be aware of whether the climate conditions in a given region and at a specific time are appropriate for tourist activities and what can be expected in future decades. For the development and implementation of targeted adaptation strategies to climate change, it is essential to examine the vulnerability of the tourism sector to climate change and the different components of the vulnerability. Vulnerability expresses the extent to which the sector is susceptible to or unable to cope with the adverse effects of climate change (Schneider, S.H. *et al.* 2007). Each region is vulnerable to changes in different ways and to different degrees (Pálvölgyi, T. *et al.* 2010). The territorial and sectoral strategic integration of adaptation to climate change requires a wide range of information on territorial, environmental, economic and social vulnerability to change.

Several tools have been developed to analyse the complex climate vulnerability of tourism. The most commonly used tool is the CIVAS (Climate Impact and Vulnerability Assessment Scheme) model, developed by the CLAVIER international climate research project. The model relies on the approach published in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC (IPCC, 2007). It provides a uniform conceptual and methodological framework for quantitative climate impact assessments. The theoretical structure of the CIVAS model is presented in *Figure 1*.

The model describes climate change vulnerability as a complex indicator that identifies complex natural, economic and social vulnerability caused by climate change by integrating exposure, sensitivity and adaptability indicators (see *Figure 1*). The advantage of the model is the quantifiability of the complex vulnerability and its components, which makes it possible to compare different tourism activities, destinations and periods objectively.

One of the initial steps in the CIVAS model is the determination of the exposure of tourism to climate conditions or climate change. Exposure is based on the climatic elements (conditions) of the given geographical area and their changes (see *Figure 1*). Numerical values for exposure are provided by measured or observed meteorological data as well as estimates from global climate models (GCMs) or regional climate models (RCMs). Therefore, information from observations and from climate models is an important initial element of objective-based exposure or impact assessment and vulnerability studies.

Projections based on climate models are, in all cases, burdened with uncertainties, which result from the natural variability of the climate system and the approximate description of the physical processes included in the models. In addition, there is no definite information on how socio-economic processes affecting the climate system may develop in the future (Szépszó, G. *et al.* 2016). In order to understand future climatic conditions and impacts on different sectors, including tourism, it is necessary to take into account the uncertainties of climate projections, too.

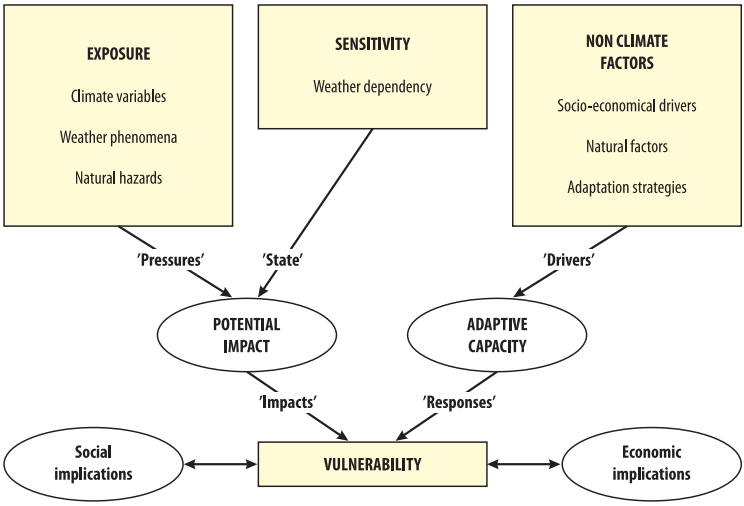

Fig. 1. The theoretical structure of the CIVAS model. *Source*: Self-edited scheme based on Pálvölgyi, T. *et al.* 2010.

Results based on a single climate model experiment performed on a single emission scenario do not serve as a reliable forecast of the expected conditions and do not provide the opportunity to quantify the uncertainties in the projections. A qualitative improvement is the application of a well-selected model ensemble, based on multiple scenarios, implemented with multiple regional models driven by different global models. This method can ensure a balanced presentation of uncertainties arising from the choice of different scenarios or from the differences in RCMs, or the GCMs that provide the boundary condition for RCMs (Szépszó, G. *et al.* 2016).

Observational and model data include a wide range of climate data. The exposure of the tourism sector to climate is usually characterised not by individual meteorological parameters but mostly by special complex tourism climate assessment tools (Endler, C. *et al.* 2010; Amelung, B. and Nicholls, S. 2014). These tools integrate several climate data relevant for tourism in various ways. They range from simple indices that require only a few climatic variables (e.g. the indices of Mieczkowski, Z.T. 1985; Kovács, A. *et al.* 2016; Scott, D. *et al.* 2016) to complex assessment matrices (de Freitas, C.R. *et al.* 2008) and to evaluation schemes (Matzarakis, A. 2007).

The number of studies analysing the climate exposure of the tourism sector for the area of Hungary or for some parts of the country is very low, and they have primarily examined the present conditions (e.g. Németh, Á. 2013; Kovács, A. and Unger, J. 2014a, b; Kovács, A. *et al.* 2016). The expected future circumstances based on RCM outputs were only evaluated by Kovács, A. (2017), Kovács, A. *et al.* (2017), and Sütő, A. and Fejes, L. (2019).

In this study, we analyse the exposure of the tourism sector to climate change in Hungary with the help of a tourism climate index. First, the present conditions are examined based on a gridded observational database, which forms the basis for assessing future circumstances. Afterwards, the expected future conditions are studied, for which we use regional climate model outputs. In order to interpret the uncertainties of the climate projections properly, we use two different RCM results relying on two emission scenarios.

Data and methods

The climate of Hungary is highly varied, as it is affected by the oceanic climate with balanced temperature and precipitation, the continental climate with extreme temperatures and low precipitation, and the Mediterranean climate with aridity in summer and rainy conditions in winter. Another major determinant of the climate is the topography. As the country is located in the Carpathian Basin and most of its surface is flat or gently undulating at low elevations, the impact of the Carpathians is of considerable importance. In most of the country, the annual mean temperature is between 10 and 11 °C, which is determined by the geographical location, the altitude, and the distance from the sea. Based on the period 1971–2000, the first weeks of January are the coldest, while late July and early August are the warmest periods of the year. The variability of temperature from year to year is generally smaller in the summer months than in the winter months (https://www.met.hu/en/eghajlat/magyarorszag_eghajlata/). In the period 1961–2010, the temperature was found to increase in every season and on an annual basis, particularly in the last three decades, thus, confirming the trends occurring throughout Europe (Spinoni, J. *et al.* 2015). In this period, the number of warm nights and warm days was significantly increasing, showing a universal warming trend in the region. In the annual occurrence of cold nights, a large part of the region experienced a significant decrease (Lakatos, M. *et al.* 2016).

The long-term average annual precipitation is 500–750 mm in the country, but there are significant differences among the various regions due to the topography and the influences of the Mediterranean Sea and the Atlantic Ocean. Based on the period 1971–2000, the wettest parts of the country (more than 700 mm) are the southwestern region as well as the higher areas, while the lowest precipitation (less than 500 mm) is detected in the middle part of the Great Plain. The average annual precipitation decreases from southwest to northeast. Precipitation is highest between May and July and lowest between January and March. Precipitation is fairly variable, with considerable fluctuations from year to year. There may be a lack of precipitation in any month (https://www.met.hu/en/eghajlat//magyarorszag_eghajlata/). The risk of aridity and drought is high in Hungary (Spinoni, J. *et al.* 2013; Gavrilov, M.B. *et al.* 2020). In the period 1961–2010, precipitation showed no significant trend, though it has increased slightly on an annual basis in the last two decades. The figures, thus, show a small increase relative to the 1980s, which was the driest decade analysed (Spinoni, J. *et al.* 2015).

For the quantification of the exposure of tourism to climate change, in this study the modified version of the widely used Tourism Climate Index (*TCI*) of Mieczkowski, Z.T. (1985) was applied (Kovács, A. *et al.* 2016, 2017), hereinafter referred to as *mTCI*. The *TCI* and *mTCI* quantify the impact of climatic conditions on general outdoor tourism activities (e.g. sightseeing, recreation and other light physical activities outdoors).

The original form of the *TCI* consists of five sub-indices, which in turn rely on monthly values (monthly means and monthly sums in the case of precipitation) of seven basic climate parameters relevant for tourism: daily maximum air temperature, minimum relative humidity, mean air temperature, mean relative humidity, precipitation sum, sunshine duration and wind speed. From these parameters, precipitation sum, sunshine duration and wind speed values are rated in itself with special rating score systems, from values zero (unfavourable) to five (optimal), forming sub-indices *R*, *S* and *W*, respectively. The temperature and humidity data are combined into two sub-indices, the so-called daily comfort index (*CIa*) and daytime comfort index (*CId*). These sub-indices describe the thermal comfort conditions for the whole day (*CIa*) and at the warmest period of the day (*CId*). Correspondingly, *CIa* is based on the daily mean air temperature and mean relative humidity, while *CId* rates the effect of the

daily maximum temperature and minimum relative humidity. In fact, the rating systems of *CId* and *CIa* rely on the combined effect of the corresponding temperature and humidity on thermal comfort, which is expressed in the form of the Effective Temperature (*ET*). *ET* is one of the earliest and simplest empirical thermal indices, and it takes into account the temperature and humidity variables only (Houghten, F.C. and Yaglou, C.P. 1923). The rating scores of the *ET* values in the *TCI* range from minus three to five.

Finally, the overall *TCI* value is obtained by calculating the weighted sum of the sub-indices (*CId*, *CIa*, *R*, *S* and *W*) with the use of weight factors that express their relative importance within the overall climate evaluation (Mieczkowski, Z.T. 1985; Kovács, A. *et al.* 2016, 2017):

$$TCI = 2(4CId + CIa + 2R + 2S + W) \quad (1)$$

The *TCI* values are classified on a predefined scale of –20 to +100, with higher values indicating a more favourable climatic potential for outdoor tourism activities (Mieczkowski, Z.T. 1985) (*Table 1*).

Table 1. The evaluation system of the Tourism Climate Index (TCI)

TCI values	Descriptive categories
90–100	ideal
80– 89	excellent
70– 79	very good
60– 69	good
50– 59	acceptable
40– 49	marginal
30– 39	unfavourable
20– 29	very unfavourable
10– 19	extremely unfavourable
-20– 9	impossible

Source: Mieczkowski, Z.T. 1985.

The *mTCI* index has improved the thermal relevance of the original *TCI* by integrating the most widely used and up-to-date thermal comfort index Physiologically Equivalent Temperature (*PET*) (Höppe, P. 1999) into the *CId* and *CIa* components of the *TCI* instead of the *ET* (Kovács, A. *et al.* 2016, 2017; Kovács, A. 2017). *PET* takes into account the combination of four climate parameters (air temperature, air humidity, wind velocity, and thermal radiation) and personal factors, such as clothing and human activity, which both determine the thermophysiological effect of the atmospheric environment on the human body.

In addition to the shortcoming of the thermal aspect, the other disadvantage of the *TCI* is that the rating schemes of the sub-indices are arbitrary and had never been tested empirically against the perceptions and preferences of humans. Therefore, in the *mTCI*, a new *PET* rating system was developed and integrated into *CId* and *CIa*, which reflect the seasonally different thermal perception patterns of Hungarian residents. This modification improves the credibility of the thermal rating scores of the original *TCI*, thus enhancing the potential of *TCI* to evaluate the thermal comfort conditions of the atmospheric environment (Kovács, A. *et al.* 2016, 2017; Kovács, A. 2017). To achieve this, data from an extensive thermal comfort survey were used, which were collected from spring to autumn; therefore, the winter period is excluded from the analysis with *mTCI* for Hungary. In *mTCI*, the *PET* rating scores of *CId* and *CIa* range from zero (unfavourable) to five (optimal). In practice, the *CId* and *CIa* sub-indices are derived utilising daily maximum and daily mean *PET* values, respectively.

The original rating system of *R*, *S* and *W* sub-indices, the calculation formula of the index (Eq. 1) and the overall evaluation system (*Table 1*) were not modified. Full details on the construction of *TCI* are presented in Mieczkowski, Z.T. (1985), Kovács, A. *et al.* (2016, 2017) and Kovács, A. (2017), while the full conceptual and methodological aspects of the modification of *TCI* are available in Kovács, A. *et al.* (2016, 2017) and Kovács, A. (2017).

In this study, we present the *mTCI* results on a monthly basis (from March to November). To achieve this, we used the monthly values (monthly means and monthly sum in the case of precipitation) of the seven necessary daily climate parameters. As the calculation of *PET* in the *mTCI* requires some kind of thermal radiation data, global radiation or cloud cover

data are also necessary. The daily maximum *PET* was calculated from daily maximum temperature, minimum relative humidity, mean wind speed and mean cloud cover, while the daily mean *PET* values were obtained from daily mean temperature, mean relative humidity, mean wind speed and mean cloud cover data. The *PET* values were determined using the RayMan radiation and bioclimate model (Matzarakis, A. *et al.* 2010).

We present the results for a thirty-year climate period describing the present climate conditions as well as for two climate periods that characterise the possible future conditions. Thus, we used multi-year mean monthly raw data, and from them, we calculated multi-year mean monthly *mTCI* values.

The *mTCI* was first calculated for the reference period 1971–2000, which characterises the current climate conditions. For performing this calculation, the observational database CarpatClim-HU (Bihari, Z. *et al.* 2017) developed by the Hungarian Meteorological Service (HMS) was used. The database contains grid point data with a horizontal spatial resolution of 0.1° × 0.1° (approx. 10 km) for the area of Hungary (covering the grid of 45.8°N–48.5°N and 16.2°E–22.8°E). This 0.1° resolution database represents 1,104 grid points across Hungary (*Figure 2*). These grid point values were generated from controlled, homogenised meteorological measurement data, which were interpolated to the 0.1° resolution grid and harmonised along national borders. The raw data were provided by the HMS, and we calculated the multi-year monthly *mTCI* values from them.

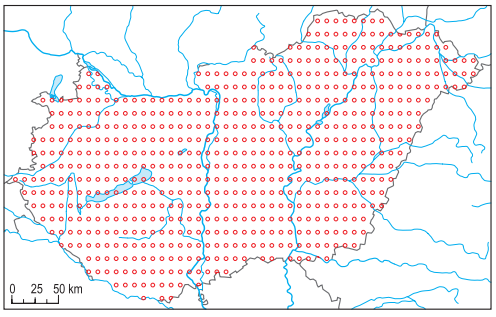

Fig. 2. The 0.1° × 0.1° resolution grid of the homogenised, interpolated observational database CarpatClim-HU and the interpolated regional climate model simulations HIRHAM5 and RACMO22E. *Source*: Szépszó, G. *et al.* 2016.

The investigated climate models for evaluating future conditions were chosen from the EURO-CORDEX experiments (Jacob, D. *et al.* 2014). EURO-CORDEX is the European branch of the international CORDEX initiative (Giorgi, F. *et al.* 2009) and contains climate change projections for Europe based on an ensemble of RCM simulations (https://www.euro-cordex.net/). In EURO-CORDEX, the simulations have been conducted at two different spatial resolutions: the general CORDEX resolution of 0.44° (EUR-44, approx. 50 km) and a finer resolution of 0.11° (EUR-11, approx. 12.5 km). In order to quantify the tourism climate conditions for the area of Hungary, the small-scale EUR-11 experiments were selected. The data were obtained from the archives published and distributed via the Earth System Grid Federation (ESGF) under the project name CORDEX (Cinquini, L. *et al.* 2014). For the analysis, two RCMs driven by the same GCM were selected (*Table 2*).

The two selected RCMs are the HIRHAM5 (by the Danish Meteorological Institute, DMI) (Christensen, O.B. *et al.* 1998) and the RACMO22E (by the Royal Netherlands Meteorological Institute, KNMI) (van Meijgaard, E. 2012). Their driving model was the EC-EARTH (by the Irish Centre for High-End Computing, ICHEC, http://www.glisa-climate.org/node/2238) (Hazeleger, W. *et al.* 2010). The simulations with the RCP4.5 and

Table 2. The climate model experiments used in the analysis

Driving global climate model	Regional climate model	Institute	Emission scenario
EC-EARTH	HIRHAM5	DMI	RCP4.5 RCP8.5
	RACMO22E	KNMI	RCP4.5 RCP8.5

RCP8.5 emission scenarios (Representative Concentration Pathways, Moss, R.H. *et al.* 2010) were used in both cases (see *Table 2*). These two scenarios are quite different in terms of possible greenhouse gas concentration trajectories. RCP4.5 is an intermediate stabilisation pathway in which radiative forcing is stabilised at 4.5 Wm^{-2} in the year 2100. In RCP8.5, emissions continue to rise throughout the 21st century, with radiative forcing reaching 8.5 Wm^{-2} for 2100.

In selecting these two models, the first important consideration was that the various data needed to calculate *mTCI* be available. The second aspect was to select models with validation results being satisfying in terms of model error when comparing them with observations. Considering this aspect, we compared the monthly mean air temperature and monthly precipitation sum (which are two important parameters in *mTCI*) simulated by the two selected models to those based on the observations (CarpatClim-HU) for the reference period (1971–2000) for Hungary. Comparing the model results to the observed data, reasonable agreement can be observed (*Figure 3*). Thirdly, we selected model projections that show representative results (especially for air temperature and precipitation) to display the uncertainties correctly with the models. This aspect was studied through Taylor diagrams of the mean air temperature and precipitation sum for the reference period again. We compared 12 GCM-RCM combinations from the EURO-CORDEX experiments to the observations (CarpatClim-HU), and the results demonstrate that the degree of correspondence between the models and observations is one of the highest in the two cases used (HIRHAM5 and RACMO22E) (*Figure 4*). During the model selection, we also took into account the results of Torma, Cs. Zs. (2019), Kis, A. *et al.* (2020) and Torma, Cs. Zs. *et al.* (2020) who validated several EURO-CORDEX experiments (including HIRHAM5 and RACMO22E) against CarpatClim observations for the Carpathian Region.

For the assessment of future conditions, the 2071–2100 period was selected, while the reference period of the model experiments was the same as that of the observational database (1971–2000). The downloaded data were pre-processed with Climate Data Operator (CDO) in order to interpolate from the EUR-11 grid to the CarpatClim-HU grid (see *Figure 2*) and to get multi-year monthly averages from the raw data.

When evaluating projections for the future, it should be taken into account that the results of regional (and global) models are necessarily burdened with uncertainties; therefore the systematic model errors need to be eliminated somehow. Several methods exist to reduce these errors, of which we used the so-called delta method (Hawkins, E. *et al.* 2013). This means that the future model results were not in themselves interpreted but relative to the models' own reference periods

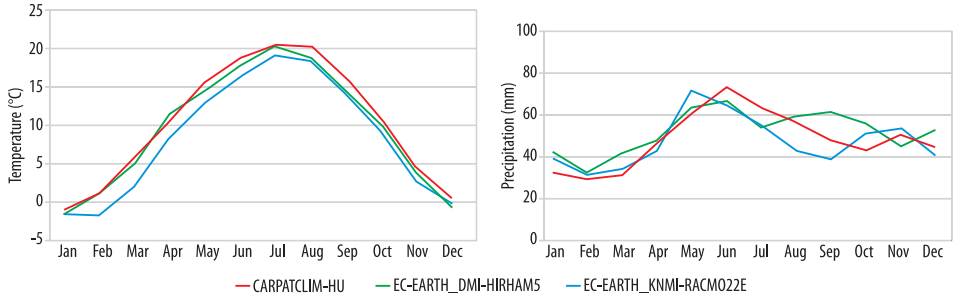

Fig. 3. Annual course of the monthly mean air temperature (left) and precipitation sum (right) of the RCMs HIRHAM5 andRACMO22E and of the observational database CarpatClim-HU for the reference period (1971–2000) for Hungary

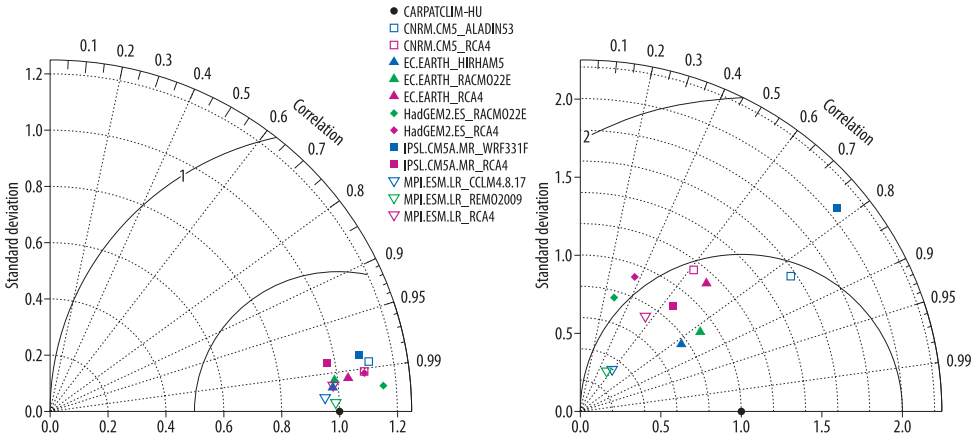

Fig. 4. Taylor diagrams of the mean air temperature (left) and precipitation sum (right) for 12 GCM-RCM combinations from the EURO-CORDEX experiments versus the observations CarpatClim-HU for the reference period (1971–2000) for Hungary

by specifying the change values. Thus, for each grid point and each variable of the models, we determined the differences between their future values (2071–2100) and their values for the reference period (1971–2000). We then added these changes to the observed data (CarpatClim-HU) from the reference period (1971–2000) to obtain the corrected future values of the given model.

We present the monthly *mTCI* results at the district level for Hungary. The district is a small-scale administrative-territorial unit in Hungary; the analysis on that level can provide effective results for tourists, tourism professionals and decision-makers. To achieve this, after calculating the monthly values of *mTCI* for each grid point, district averages were generated from them, and finally, the obtained spatial distribution was displayed on maps for each month.

Results

Mapping of *mTCI* results was performed according to the descriptive category system shown in *Table 1*. This categorisation is more straightforward for the users than the raw values of *mTCI*. Due to the low number of cases below the value 40, these values were merged into a single category called 'unfavourable'. The outputs for the period 1971–2000 based on the CarpatClim-HU database are presented in *Figure 5*.

The most unpleasant month during the analysed period is November, with 'unfavourable' conditions in almost the whole country except the Southern Great Plain where 'marginal' conditions prevail. November is followed by March with mostly 'acceptable' conditions. In this month, only some mountainous regions remain 'marginal', while in some southern parts of the country 'good' conditions are already appearing. In April, there is a significant improvement in the tourism climate potential, reaching 'very good' conditions or even 'excellent' circumstances in the Great Plain. The climate potential remains similarly favourable in May, only a slight change in the spatial distribution is displayed. From June, a gradual decline is observed, which lasts until September. This means that the 'excellent' conditions are replaced with 'very good' in June, and even 'good' category appears in some places. For July and August, it can be observed that the

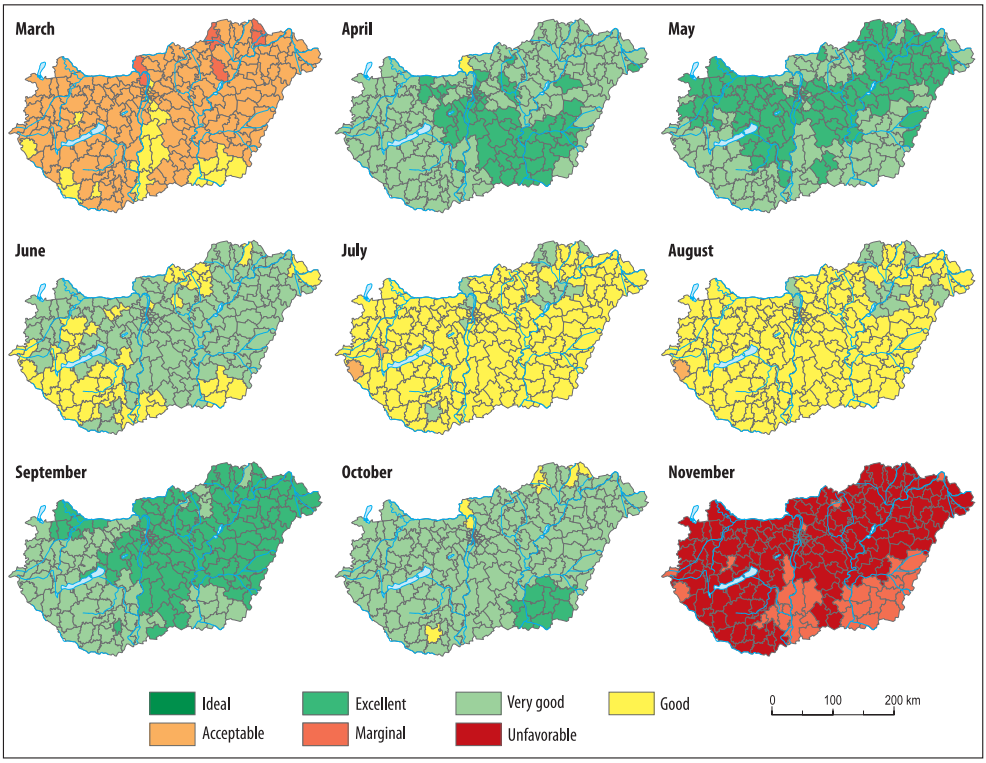

Fig. 5. Spatial distribution of *mTCI* categories by district on a monthly basis for the period 1971–2000 based on CarpatClim-HU database

proportion of areas characterised only as 'good' is significantly increasing at the expense of a 'very good' evaluation. It is worth mentioning that these 'good' conditions also indicate favourable potential for outdoor activities. In September, there is a considerable recovery in the climate conditions, and more than half of the country is characterised with the 'excellent' category again. With this improvement, the spatial pattern of *mTCI* becomes similar to that experienced in May. In October, a slight decrease in *mTCI* is starting. In this period, most parts of the country are characterised by 'very good' conditions. By November, a much more pronounced decline by 3-4 categories can be observed, reaching the 'unfavourable' or 'marginal' classification for outdoor activities (see *Figure 5*).

In summary, there is a significant improvement during the spring, but a slight decline from June to September. During the autumn, an improvement is detected again, while from November, the climate potential is decreasing. According to the classification of Scott, D. and McBoyle, G. (2001), who examined the potential annual courses of *TCI*, a bimodal structure emerges, which means that the spring and autumn have more favourable climate conditions than the summer period, which is in agreement with our results.

In relation to future trends in *mTCI* distribution, we first analyse the output of HIRHAM5 simulation based on RCP4.5 scenario (*Figure 6*). According to the results, the pattern of *mTCI* signals bimodal structure again because we find the most pleasant con-

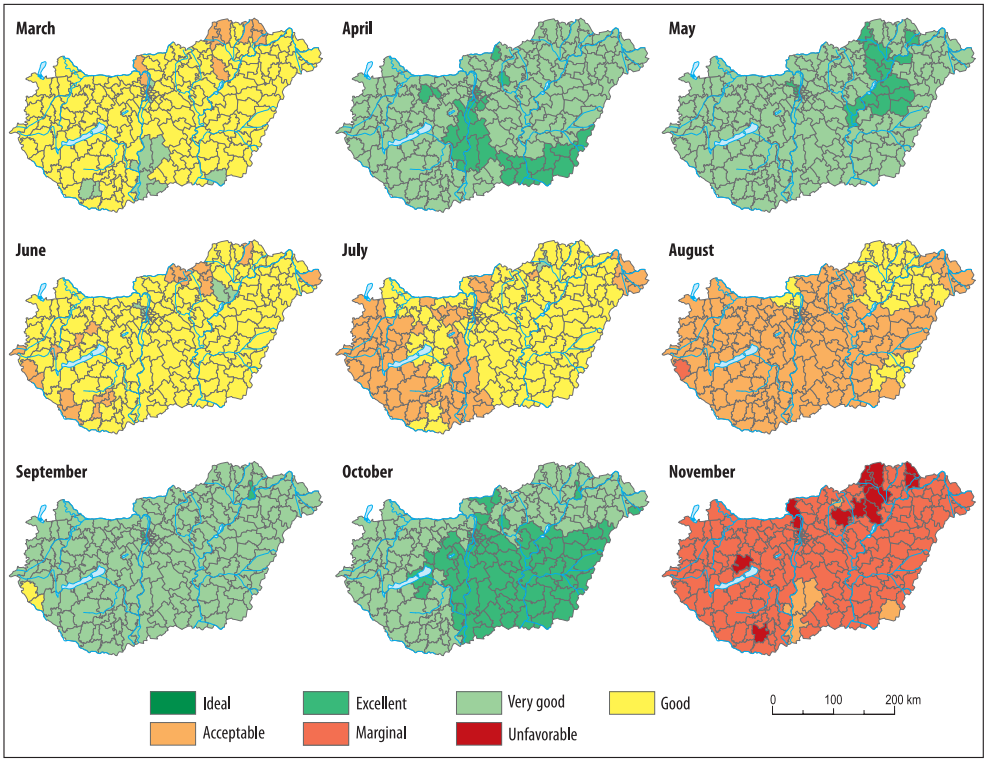

Fig. 6. Spatial distribution of *mTCI* categories by district on a monthly basis for the period 2071–2100 based on the EC-EARTH driven HIRHAM5 simulation with RCP4.5 scenario

ditions in April, May, September and October with 'very good' or 'excellent' evaluation.

In March and November, a significant improvement will be probable compared to the reference period (1971–2000, CarpatClim-HU), which means a one-category change in most of the country (see *Figure 5* and *6*). In addition to these months, a similar improvement is expected in October in the Great Plain. In April, significant differences are not observed. However, from May to September, large parts of the country may experience a decline in climate potential by a category. Specifically, in May and September, most of the country will likely be classified as 'very good' instead of 'excellent'. In all months of the summer, the change in the *mTCI* pattern also shows an unfavourable trend. In June, 'good' circumstances will be probable at the expense of 'very good', while in a few districts 'acceptable' conditions are already displayed. In the Transdanubian areas in July and most of the country in August, only 'acceptable' conditions may be experienced instead of 'good' potential (see *Figure 5* and *6*).

In conclusion, we can expect an increase of *mTCI* with one category or in some cases, tourism climate conditions will remain unchanged in March, April, October and November. However, in the period between May and September, which has a significant tourist turnover in Hungary, there is a decline by a category or possibly stagnation in some places.

Bimodal annual structure of *mTCI* is detected again when analysing the RACMO22E

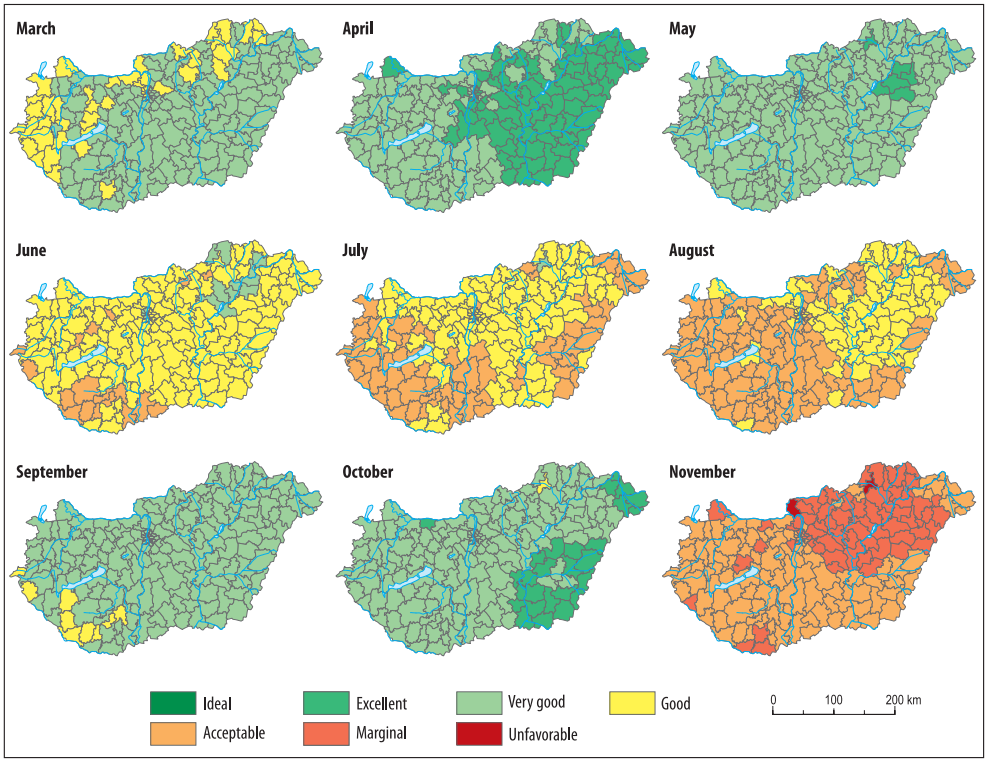

Fig. 7. Spatial distribution of *mTCI* categories by district on a monthly basis for the period 2071–2100 based on the EC-EARTH driven RACMO22E simulation with RCP4.5 scenario

outputs based on RCP4.5 scenario (*Figure 7*). Considering the future projection, similar tendencies are found, as in the case of the HIRHAM5, RCP4.5 experiment (see *Figure 6* and *7*). Between them, only slight differences occur that do not exceed one category. The largest differences, more precisely category deviation for the largest area, are indicated for March, April, October and November. In March and November, RACMO22E indicates more pleasant conditions in a large part of Hungary than HIRHAM5. In April, a slight improvement is detected in the eastern half of the country compared to HIRHAM5 and also to the CarpatClim-HU results, while in October, a smaller area is affected by the most favourable conditions than in the case of the HIRHAM5 experiment. During the period from May to September, the tourism climate conditions based on the two models are almost identical; only the pattern in July and August indicates a slight deviation for the eastern part of Hungary.

The model experiment HIRHAM5 using the RCP8.5 scenario usually shows an improvement in the climate potential in March, April, October and November compared to the reference period (*Figure 5* and *8*). The change in March and November is particularly remarkable, as all areas of the country may experience conditions that are more favorable by one or two categories. In April and October, the conditions remain unchanged in Transdanubia and are more pleasant by a category in the eastern part of the country. From May to September, almost

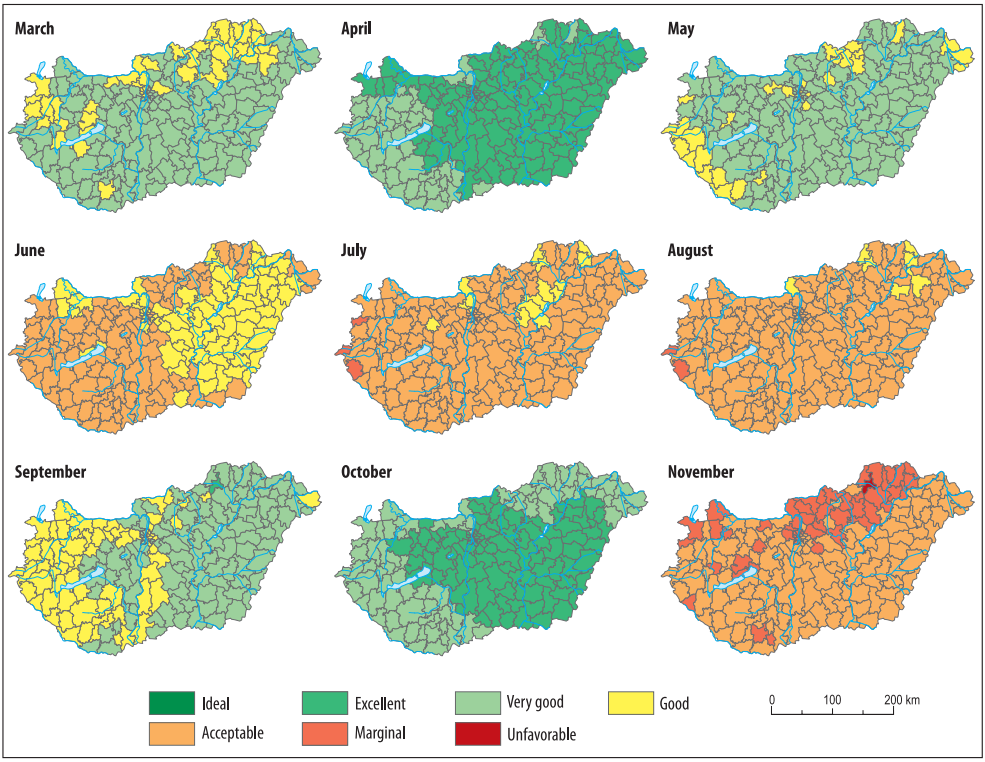

Fig. 8. Spatial distribution of *mTCI* categories by the district on a monthly basis for the period 2071–2100 based on the EC-EARTH driven HIRHAM5 simulation with RCP8.5 scenario

all regions of the country may become less favourable typically by a category.

This scenario indicates larger changes or changes affecting larger areas in both (positive and negative) directions compared to the HIRHAM5, RCP4.5 experiment (*Figure 6* and *8*). Specifically, 'very good' conditions prevail instead of 'good' in March, and there are 'acceptable' conditions instead of 'marginal' in November. In April and October, the ratio of the 'excellent' classification is higher in the RCP8.5 case. In May and September, when an unfavourable tendency is observed, some parts of the country are characterised with 'good' conditions in place of 'very good'. During the summer months, 'acceptable' became the dominant category in most parts of Hungary at the expense of 'good' that was typical for RCP4.5.

The tendencies shown by the RACMO22E, RCP8.5 experiment are consistent with the previous findings (*Figure 9*). The output of this model is similar to the HIRHAM5, RCP8.5 results (*Figure 8* and *9*). There are at most one-category differences between them. The projection for the summer period is almost the same, especially for July and August. The highest differences occur in spring and autumn, though they affect small areas only and never exceed one category.

Similar to the HIRHAM5 case, the future changes are typically larger in RACMO22E with RCP8.5 compared to RACMO22E with RCP4.5 (see *Figure 7* and *9*). In particular, the decline between May and September is more significant in RCP8.5; that is, the ratio of districts with only 'good' ('acceptable') potential is higher in May and September (in June, July

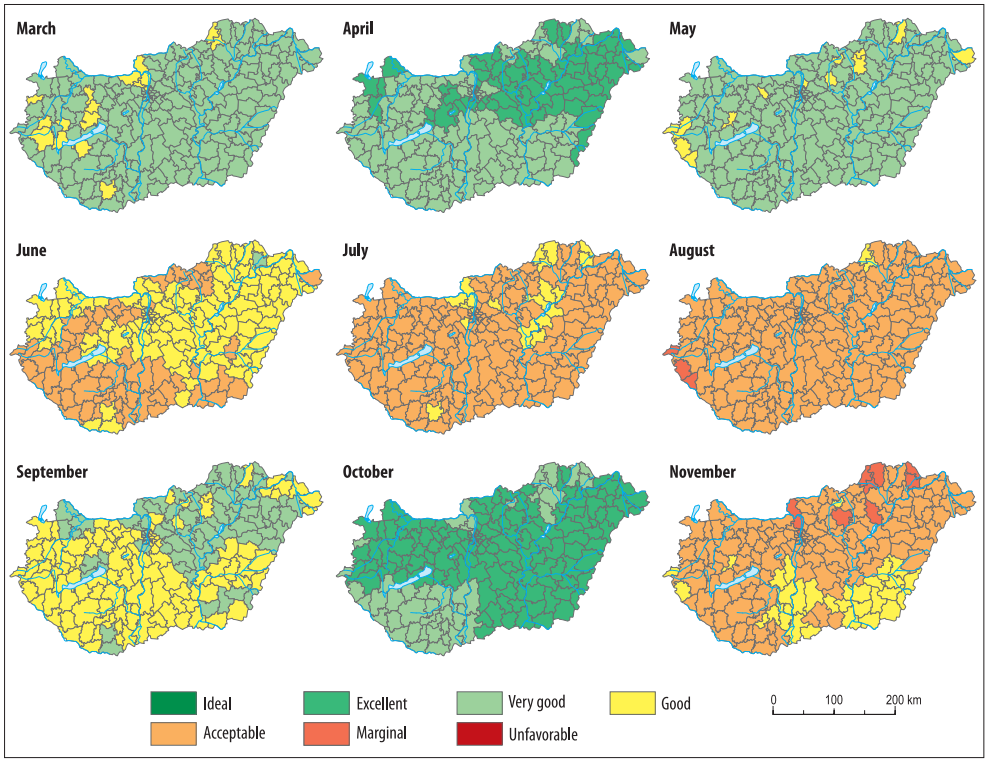

Fig. 9. Spatial distribution of *mTCI* categories by district on a monthly basis for the period 2071–2100 based on the EC-EARTH driven RACMO22E simulation with RCP8.5 scenario

and August). Further, the degree of improvement in March, October and November is also more considerable in the RCP8.5 case.

Summary and concluding remarks

According to the current and future spatial patterns of tourism climate conditions in Hungary through observations and regional climate model data, the following outlines can be drawn:

– The annual course of the present and future conditions is bimodal in all cases, that is, the most favourable circumstances are found in spring and autumn, while in the summer period, a decline in climate potential is observed.
– According to future projections, the tourism climate potential for March, April, October and November usually brings an improvement, while between May and September, a decline is generally expected.
– For a given RCP emission scenario, the expected trend is quite similar for the HIRHAM5 and RACMO22E experiments, with at most one-category differences between them, mainly during the transition seasons.
– For a given climate model, using the RCP8.5 scenario, the changes in both directions are typically larger or they affect a larger area than in the case of RCP4.5.

The obtained results are consistent with the outcomes of the investigation carried out in the previous CRIGiS-NAGiS project

(Bihari, Z. *et al.* 2015) in which also the current and future tourism climate potential for Hungary was evaluated using the *mTCI* index (among others) and by almost the same methodology (Bihari, Z. *et al.* 2015; Kovács, A. 2017; Kovács, A. *et al.* 2017). However, that assessment was based on the output of a single RCM simulation and a single emission scenario from the former scenario family (ALADIN-Climate model, A1B scenario). According to that investigation, March, April, October and November brought an improvement, while the other months a decline, which is similar to the results of this study. In this study, we used a small multimodel ensemble of simulations chosen from a more up-to-date climate model ensemble, based on multiple and up-to-date scenarios implemented with multiple regional climate models. This method could be an initial step to ensure a balanced presentation of uncertainties and to interpret the outcomes of exposure and impact studies properly.

Comparing our results with previously published international examples is a difficult task. On the one hand, the use of the *mTCI* index is not yet widespread. This measure has been adapted to the Hungarian climate conditions, though the applied methodology can be effective in any country or region, but this process requires an extended, long-term thermal comfort measurement and questionnaire survey (Kovács, A. *et al.* 2016). The credible comparability is also hampered by differences in the baseline databases used to determine the various tourism climatological indicators (basic data, observations, models, study periods) and by the variety of data processing and analysis methods, as well as the different presentation of the results (mapping, scaling, time scale). In many cases, the lack of basic information in the published articles also makes comparison difficult (Kovács, A. 2017). Nevertheless, since the *mTCI* index is similar to *TCI* in many aspects (structure, calculation) their comparison is reasonable (Kovács, A. 2017). The bimodal structure of *mTCI* and the future tendencies in the different periods of the year demonstrated in this study are in reasonable accordance with the international findings using the original *TCI* (e.g. Scott, D. *et al.* 2004; Nicholls, S. and Amelung, B. 2008; Perch-Nielsen, S.L. *et al.* 2010; Amelung, B. and Moreno, A. 2012; Kovács, A. 2017).

Our results demonstrate that climate change will have an obvious impact on tourism potential in Hungary, and therefore tourism strategy development has to take into account this effect more than before. Methods and practices to adapt to climate change should be used in both the demand and supply side of tourism. The improvement of climatic conditions in spring and autumn has the potential to extend the outdoor tourist season, which is a key element of adaptation to the altered conditions. The means of diversifying the tourism economy can be the development of different outdoor and partly indoor services usable in extended periods, too. In Hungary, cultural and gastronomic festivals, health tourism (especially the development of tourism-based medical services) or strengthening business and conference tourism can be feasible tools. The unfavourable tendency shown in summer, which is mainly due to the increasing frequency of warm (or hot) days and extreme events, may encourage tourism operators to develop non-weather and non-climate sensitive products. Themed walks, theme or leisure parks, visitor centres, indoor event spaces, indoor baths, spas or water parks can be effective solutions for this purpose. In each case, the infrastructure for hosting the tourists (accommodation, hospitality) should be adapted in space and time to the altered demand.

When evaluating the results of this study, it should be kept in mind that, in addition to climatic conditions, many social and economic factors and mechanisms (e.g. accessibility and distance, transport costs, budget) play a decisive role in the dynamics of tourism. In addition, several natural or cultural elements influence the motivation of tourists and decision-making (e.g. geology, hydrology, vegetation, historical monuments, celebrations) (Gómez Martín, B. 2005). Uncertainties could emerge not only from the

prediction of climate conditions and climate change but also from the estimation of the natural, social and economic factors affecting tourism, and, thus, the same impacts of climate change.

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Lake Balaton as an accessible tourism destination – the stakeholders` perspectives

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Abstract

This paper discusses the situation in the emerging field of accessible tourism at the Lake Balaton destination. The main objective of the study was to explore the current situation of accessible tourism at Lake Balaton, focusing on the perspectives of tourism stakeholders. Various issues were reflected upon, such as: a) the "general" accessibility of the destination in terms of the current state of accessibility of the destination as well as the accessibility of information, transportation, accommodation, food and beverage services, tourist attractions, funds and know-how; b) factors that make the destination Lake Balaton competitive as an accessible destination; and c) general attitudes of tourism stakeholders towards accessible tourism. The research focus was on the destination itself, not on individual attractions or tourism service providers. In order to assess the current situation and future prospects for accessible tourism at Lake Balaton, an exploratory quantitative online survey among stakeholders was conducted between 5 September and 5 October 2020. A total of 39 stakeholders participated in the survey, including 11 local municipality stakeholders, 8 local destination management organisations, and 20 tourism service providers (accommodation, catering or attractions/sights). The results show that the Lake Balaton destination accessibility is currently at an early stage of development and tends to target groups with low accessibility needs. Among the factors of destination competitiveness for the accessible tourism market, supportive factors (e.g. accessibility, infrastructure, and the commitment of stakeholders) are ranked first, followed by resources and attractions (landscape, climate, activities, culture, history, tourism service providers, and events) and the quality factor (including value for money, safety, perception and image). Planning and management (including positioning and branding) is the lowest ranked factor even though such aspects are critical factors and foundations for the development of accessible tourism.

Keywords: accessible tourism, stakeholder analysis, tourism service providers, Lake Balaton

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Introduction

In today's world, the issue of accessibility has been gaining growing attention (Darcy, S. *et al*. 2020; Gillovic, B. and McIntosh, A. 2020). Increasing numbers of people are living with some kind of limitations that constitute leisure constraints for them (e.g. ageing population leads to elderly people with mobility and sensory impairments, various health problems, including a growing number of people with food allergies) (Smith, R.W. 1987; Huber, D. *et al*. 2018). A quarter of the EU-28 population has been experiencing long-standing limitations due to health problems (EUROSTAT, 2020). Furthermore, 37 percent of the EU-28 population aged 15 and older reported (moderate or severe)

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physical or sensory limitations; 26.8 percent of the respective population reported moderate functional limitations of this type and a further 10.1 percent reported severe functional limitations of this type. Consequently, there is a growing need for accessible infrastructure and services, including in tourism.

Tourism plays an important role in life. Indeed, the demand for tourist mobility is increasing. As a result, a larger proportion of the population is involved in tourist activities (e.g. half of the Hungarian population can afford to participate in a domestic overnight trip). In recent decades, accessibility has been gaining more attention on both academic and practical levels. Various international projects are aiming at the development of accessible tourism supply (including transport, services, attractions etc.). The topic is also an established phenomenon in tourism research (Darcy, S. and Dickson, T.J. 2009; Darcy, S. *et al*. 2010; Darcy, S. 2010; Michopoulou, E. and Buhalis, D. 2013; Michopoulou, E. *et al*. 2015; Vila, T.D. *et al*. 2015; Gillovich, B. *et al*. 2018; Gillovic, B. and McIntosh, A. 2020).

Based on the quantitative research among the stakeholders of the Balaton destination, the article addresses the tourism accessibility in this area. The main goal of the study is to explore the current situation of accessible tourism at Lake Balaton, focusing on the tourism stakeholders' perspectives. The research focus is on the destination itself, not on the accessibility of individual attractions or tourism service providers. Our study refers to tourism destination as a whole entity consisting of various stakeholders (public and private) working together on providing the (accessible) tourism experience for visitors. There are only a few research studies focusing on the accessibility of a tourism destination from the stakeholders` perspective (ex. Kastenholz, E. *et al.* 2012; Nyanjom, J. *et al*. 2018), and this research is the first focusing on the destination Balaton. The paper thus contributes to the sparsely researched area of accessible tourism destination development, focusing on stakeholders, as their collaboration in this process has been an important emerging topic.

Theoretical background

Accessible tourism is often associated with the mobility impairment of participants in tourism and the physical accessibility of tourist locations or services (Darcy, S. and Dickson, T.J. 2009; Darcy, S. *et al*. 2020). In recent years, however, the definitions have become broader, with the focus shifting to tourism that is accessible to a broad circle of people. Accessible tourism, including 'tourism for all' or 'inclusive tourism' (Takayama Declaration, 2009), is intended for all persons who have restrictions on access to tourist services. These may include elderly, people with a disability, people with health problems or people that do not understand the local language (UNWTO, 2016). Tourism barriers, constraints and obstacles to travel faced by people with disabilities have been recently reconceptualised into a four-tiered framework, consisting of issues faced by all tourists (i.e. issues faced by all people with disabilities), issues unique to specific disabilities and the moderating factors of impairment effects (McKercher, B. and Darcy, S. (2018). Appropriate adjustments to tourism programmes and effective strategies in confronting travel constraints are needed for greater inclusiveness (Scheyvens, R. and Biddulph, R. 2018; Huber, D. *et al*. 2018; Gabruč, J. and Medarić, Z. 2021). Inclusive tourism and inclusive tourism development are increasingly at the forefront of tourism research (Biddulph, R. and Scheyvens, R. 2018; Scheyvens, R. and Biddulph, R. 2018; Nyanjom, J. *et al*. 2018). Additionally, social tourism scholars are seeking to identify ways in which tourism can be more inclusive, considering it as a social right (McCabe, S. and Diekmann, A. 2015) and exposing its inclusive role in societies (Diekmann, A. *et al*. 2018).

Accessible tourism may be seen as "a process of enabling people with disabilities and seniors to function independently and with equity and dignity through the delivery of universal tourism products, services and environments. The definition is inclusive of the mobility, vision, hearing and cognitive dimen-

sions of access" (Darcy, S. and Dickson, T.J. 2009, 33). It draws attention to the three values in which accessible tourism as a process is grounded, namely: independence, equity and dignity (Darcy, S. and Dickson, T.J. 2009). In this context, accessible tourism is the process required to ensure that transport, accommodation, destinations and attractions across the tourism system appropriately meet the needs of people with disabilities (Darcy, S. and Buhalis, D. 2011). Darcy, S. and Buhalis, D. (2011, 10-11) additionally adapted this definition trying to provide an overall framework for an understanding of accessible tourism:

"Accessible tourism is a form of tourism that involves collaborative processes between stakeholders that enables people with access requirements, including mobility, vision, hearing and cognitive dimensions of access, to function independently and with equity and dignity through the delivery of universally designed tourism products, services and environments. This definition adopts a whole of life approach where people through their lifespan benefit from accessible tourism provision. These include people with permanent and temporary disabilities, seniors, obese, families with young children and those working in safer and more socially sustainably designed environments."

The definition includes different groups of people and it highlights the importance of the cooperation between stakeholders across demand, supply and coordination (Diekmann, A. *et al*. 2012; Nyanjom, J. *et al.* 2018), which is crucial for the future development of inclusive destinations and accessible tourism experiences (Gillovic, B. and McIntosh, A. 2020; Darcy, S. *et al*. 2020), which other groups of people in the community can also benefit from.

"Tourism destinations are facing intense and increasing competition worldwide, while consumers are ever more demanding, requiring not only service quality but also socially responsible and sustainable destinations" (Kastenholz, E. *et al*. 2012, 369). The leisure and tourism industry and its services can significantly contribute to social sustainability by enhancing the quality of life of individuals by means of their social/travel inclusion and the provision of accessible services (Darcy, S. *et al*. 2010; Dolnicar, S. *et al.* 2012).

The current discourses on accessible tourism and its understanding, management and development are commonly placed in the context of economically, socially, and environmentally sustainable communities (Michopoulou, E. *et al*. 2015). Nevertheless, in reality, too few tourism stakeholders give any real attention to the business activities that are considered socially, economically and environmentally sustainable. Moreover, the social, environmental and financial considerations of accessible tourism have been so far largely ignored – also in the sustainable tourism research (Darcy, S. *et al.* 2010, 516).

Accessible tourism is (becoming) a new market niche for the tourism market (Alén, E. *et al*. 2012; Vila, T.D. *et al*. 2015; Bowtell, J. 2015; Michopoulou, E. *et al.* 2015; GFK, 2015; Gondos, B. and Nárai, M. 2019). The destinations are often compared in terms of accessibility (Vila, T.D. *et al*. 2015), and destination competitiveness for the accessible tourism market and related factors and attributes are studied and compared between different destinations. Bowtell, J. (2015, 203) claims that 'the accessible tourism market is a distinct sector, possessing the capacity for extensive future growth, and thus presents major travel providers with a potentially substantial and lucrative market, generating potential revenues of 88.6 billion EUR by 2025'.

In 2015, accessible tourism demand within the EU generated a total economic contribution of 786 billion EUR in terms of economic output, 356 billion EUR in terms of gross value added, and 394 billion EUR in terms of GDP. Within the region, 8.7 million people were employed in this area (GFK, 2015). The accessible tourism market has been estimated at approximately 27 percent of the total population and 12 percent of the tourism market. These figures take into account the large proportion of senior travellers (since people over 60 years of age will constitute 22 percent of the global population in 2050), people with disabilities and families with small children. The accessible travel market presents a golden opportunity for destinations that are ready to receive these visitors, since they

tend to travel more frequently during the low season, usually accompanied or in groups, make more return visits and, in some parts of the world, they spend more than average on their trips (UNWTO, 2016, 4-5).

Destination accessibility and accessible market as a market opportunity

Accessible tourism could thus be understood as a tool to increase the destination's competitiveness with a focus on accessible tourism as a core development strategy. Morelli, L. *et al.* (2006) list a number of factors that make a tourist destination accessible, including significant market volume, the multiplying effect of the presence of people accompanying customers with disabilities, market growth – particularly due to the population ageing, opportunities to develop domestic tourism, the possibilities for off-season business, the positive effects for other tourist groups, benefits for residents etc. However, the successful development of accessible tourism can only be achieved through a stakeholder participatory approach leading to potentially enhanced stakeholder involvement in the destination.

Stakeholder collaboration is an important issue in the development of an accessible tourism destination. In the study by Nyanjom, J. *et al*. (2018), it is pointed out that when multiple and diverse stakeholders exist, an organic, circulatory and developmental approach to stakeholder collaboration should be adopted. This inclusive tourism stakeholder collaboration framework – consisting of people with disabilities, organisations of people with disabilities, tourism service providers and government agencies, as four key stakeholder groups – presents an innovative strategy aimed at increasing stakeholder participation and stimulating system changes by encouraging the central role and involvement of people with disabilities A significant role in the accessibility of a destination is often played by social tourism stakeholders, who are usually part of the public and non-profit/voluntary sector. In relation to their role in tourism stakeholder collaboration framework, the research of Minnaert, L. (2020) reveals their unique and inclusive position in the stakeholder network. Firstly, social tourism organizations are often placed between social and commercial partners (acting as an intermediary), with the focus being on the excluded target groups. Secondly, as a consequence, the collaboration is being formed between atypical partners, usually in the form of a public-private partnership. The social tourism system in the EU and the related relationships and partnerships include three key aspects and associated stakeholders, namely the supply aspect (tourism and social tourism providers), the demand aspect (beneficiaries and social organizations) and the intermediary aspect (social tourism organizations) (Diekmann, A. *et al*. 2012).

The integration of the visions of relevant stakeholders is the key basis for the strategic positioning of tourism destinations, and this may lead to a distinctive destination brand, standing for quality, innovation, diversity, inclusion and social responsibility (Kastenholz, E. *et al.* 2012).

The study of Zajadacz, A. (2015, 196) reports on a widespread consensus about the demand for accessible tourism products and services, which is characterised by

– its constant growth, due to the incorporation of improvements in infrastructures, information, facilities granted or other determining factors;
– its boosting effect on the image of the destination;
– its significant impact on reducing the seasonality of certain destinations, especially in the case of beach tourism;
– generating more than the average revenue resulting from conventional tourism.

According to the research of Vila, T.D. *et al*. (2015, 269), there are four factors that make destinations competitive for the accessible market: (1) core resources and attractors, (2) supporting factors and resources, (3) qualifying and amplifying determinants and (4) destination planning and development. The last factor of "destination planning and manage-

ment is the most critical factor for the development of accessible tourism provisions, "as it sets the underlying infrastructure for transport, accommodation and attraction that are the key to accessible destination experiences". In this context, the concept of universal design is recognised as a key factor that supports destination competitiveness (Michopoulou, E. *et al.* 2015, 184) and "had become a central concept in the development and understanding of accessible tourism" (Darcy, S. *et al.* 2010, 519). Additionally, the study of Nzimande, N.P. and Fabula, Sz. (2020) on urban renewal intervention provides informative recommendations about public participation and stakeholder involvement in relation to increasing social sustainability and the accessibility of urban communities, where, interestingly, Airbnb providers are becoming an important destination player (Belotti, S. 2019).

Development of infrastructure, product, services, information marketing promotion and dissemination for the accessible tourism market are the common requirements for people with disabilities (Vila, T.D. *et al.* 2015, 269).

Destinations vary according to their accessibility. Vila, T.D. *et al.* (2015, 269) present four stages of tourist destination accessibility:

1. Destinations with the highest accessibility, such as big cities and capitals, that provide high levels of accessibility in their tourist offer.
2. Destinations working on accessibility with specific offers.
3. Destinations that have identified a market opportunity and are including accessibility as a differentiator in their policies.
4. Destinations that are not working on accessibility and, therefore, will not take advantage of this segment or, indirectly, of elderly and family tourism.

The same study of Vila, T.D. *et al.* (2015, 265) introduces the Ritchie and Crouch competitiveness model, a revised version of which consists of four factors of destination competitiveness for the accessible tourism market:

1. *Core resources and attractors:* factors motivating tourists to visit, including physiography and climate, mix of activities, culture and history, tourism superstructure, special events, market ties and entertainment.
2. *Supporting factors and resources:* those characteristics that support the development of the tourist industry, including accessibility, infrastructure, hospitality and political will.
3. *Qualifying and amplifying determinants:* defining of the scale, limit or potential of the destinations competitive capacity, which are beyond the control of the tourism sector, such us cost/value, location, safety/security and awareness/image.
4. *Destination planning and management:* the creation of an environment where sustainable tourism can flourish and activities carried out to support and maximise outcomes for the three other factors of the model, including quality of services/experience and positioning and branding.

Additionally, the inclusive tourism framework for accessible tourism has been developed to examine the current state of accessible tourism (Scheyvens, R. and Biddulph, R. 2018); it consists of seven key elements, namely: (1) marginalized people as tourism producers; (2) marginalized people as tourism consumers; (3) changing the tourism map to involve new people and places; (4) widening of participation in tourism decision-making; (5) promotion of mutual understanding and respect; (6) self-representation in dignified and appropriate ways; and (7) power relations transformed in and beyond tourism. The study of Gillovic, B. and McIntosh, A. (2020, 10) reveals the importance of seven elements of the inclusive tourism framework for accessible tourism, stressing the crucial role of and need for co-operation between *inquiry*, industry and community, including collaborative approaches to the research of accessible tourism.

In reality, the provision of accessible tourism is quite the opposite, and there is only a small share of the market that addresses the needs for accessible tourism. Research has shown that 63 per cent of major travel and leisure companies do not sell accessible products (Bowtell, J. 2015). Despite strong

evidence of the value of the access market, this segment continues to be largely ignored by the tourism industry worldwide, and it remains neglected to this day (Gillovic, B. *et al*. 2018). While accessible tourism is seen as a business opportunity, it is often perceived mainly as accommodating primarily disabled guests and not as a positive feature in comfort and service, potentially addressing all guests including local people and guests. Additionally, it often lacks coordination between stakeholders (GFK, 2015). Therefore, a cooperative approach is required to reshape and transform the future of the accessible tourism industry, where stakeholder cooperation is recognised as key factor for developing accessible tourism solutions, recognising the value of the market and its capitalisation (Michopoulou, E. *et al*. 2015). According to a GfK report (2015, 26), several conditions have to be met for the successful future development of accessible tourism, such as political and financial support, awareness raising and the activation of service providers, and for the guests, reliable information on accessible offers and services.

Tourism accessibility in Hungary and at the Lake Balaton destination: Review of legislation, documents and practices

According to the Hungarian Tourism Agency, in recent years there have been significant improvements in several areas across Hungary, including the Balaton region, to make facilities more accessible (UNWTO, 2019). The legal background influencing the development of accessible tourism in Hungary includes Act XXVI of 1998 on the Rights and Equal Opportunities of Persons with Disabilities (Act on the Rights of Persons with Disabilities), which guarantees the rights of persons with disabilities and promotes their equal opportunities, independent living and active involvement in social life (Egerszegi, Z. and Hegedűs, I. 2020). Additionally, it includes the ratification of the United Nations Convention on the Rights of Persons with Disabilities that grants equal accessibility for tourism and recreation services for persons with disabilities in all member countries (2007). According to Zsarnoczky, M. (2017), the adaptation of the UN's regulation was followed by the implementation of the National Disability Program (2015), which is a long-term strategy. In 2017, special awareness was raised to the importance of universal design planning. Another important document represents the Communication from the Commission 'European Disability Strategy 2010–2020: A Renewed Commitment to a Barrier-Free Europe (COM/2010/636)', which among other aspects focuses on access to the physical environment, transportation, information and communication technologies and systems (ICT), and other facilities and services.

In relation to tourism the strategic document titled The National Disability Program 2015–2025 (OGY, 2015) recognises the problem of the lack of facilities and the need to develop access to the infrastructure. Additionally, the document highlights that accessible tourism has not yet been recognised as a relevant niche, so there is a need for additional surveys on tourism demands in this field as well as training and sensitization of tourism staff. Within the document, the principle of universal design and universal planning has been emphasized, with a focus on accommodation that is accessible for all people with accessibility problems, but interesting also for people without these needs. The document also stresses tourism-oriented packages for people with disabilities, while focusing on the accessibility of accommodation and tourism attractions. The Program furtherly recognises the importance of accessible information, as it foresees the development of accessible websites covering the individual destinations and accommodations and of accessible electronic services.

The Hungarian National Tourism Development Strategy 2030, a core document defining the system of targets and methods for the Hungarian state's tourism management efforts up to 2030, sets a number of goals that

are completed by the designation of horizontal intervention areas (H), including H3 – Accessible tourism. The goal is to achieve physical and informational/communication accessibility as well as to improve the direct physical accessibility of the attractions, accommodations, and restaurants. This area is related to other horizontal areas, like cooperative tourism, which aims to establish a type of tourism that allows for visitors to experience local lifestyles by living together with the local communities, in harmony with the environment, and family-friendly tourism with a focus on establishing tourist attractions that provide shared experiences for multiple generations, and the development of family-friendly accommodation services and transport infrastructure, informative tourism working towards providing visitors with consistent and meaningful information in multiple languages, and also digital tourism that has as its goal to utilise the potential inherent in available digital technologies and then to apply it to every facet of tourism.

Lake Balaton is one of the most popular tourism destinations in Hungary. The area has a wide variety of internationally recognized natural and cultural/man-made attractions. The Balaton Uplands National Park offers visitor centres, hiking tours, and organized tours for travellers where they can get closer to nature. The lake area has been inhabited for thousands of years, so its cultural heritage (including wine and gastronomy) is of high quality and supports modern sustainable tourism. According to the Hungarian Central Statistical Office (HCSO, KSH in Hungarian), commercial accommodation facilities at the lake registered more than 1.9 million guests and almost 6 million guest nights. Two thirds of the guest nights are spent by domestic visitors. The destination's tourism performance is characterised by strong temporal (dominance of the summer months) and spatial (popularity of shore areas) concentrations. Thanks to its role and popularity, Lake Balaton has an increased awareness among 'special needs' targets, including families with small children, travellers with dog/pet etc. Recently, there have been various attempts to meet the expectations of such groups, so certain developments have been realised with the objective to make the area more accessible. In 2013, accessible tourism was one of the special themes of the European Destination of Excellence (EDEN). Somogy county and its capital Kaposvár won an award for accessible tourism, with Kaposvár being identified as an accessible city that has a tourist information centre with full wheelchair access, Braille maps and audio guides for the visually impaired, and a film with subtitles for the hearing impaired. Many of the city's museums, art galleries and cultural centres are also fully accessible for all visitors.

A very recent overview of good practices related to accessible tourism in the Balaton area, implemented as a part of the DESTI-SMART Interreg Europe project, identified some good practices in various areas of accessible tourism, such as barrier-free transport, accommodation, services, attractions and communication (Egerszegi, Z. and Hegedűs, I. 2020) with still some challenges to overcome *(Table 1).*

Lake Balaton can be viewed as a DMO (destination management organization) based destination rather than a resort type area. The tourism value chain includes settlements (local level), destination management organization, attractions, and a wide range of tourism service providers, mostly SMEs. There are no official statistical data on facilities offering accessible tourism services around Lake Balaton, so special communication channels and projects provides an overview about their role. As far as the accommodation platforms are concerned, the number of offers appropriate for tourists with access needs is less than 10 percent (e.g. Booking.com, szallasvadasz.hu). A recently developed accessible tourism database – developed by 'Hungary4All' with the support of the Ministry of Human Capacities – lists 140 service providers (covering accommodation, catering, sights/attractions) engaged in accessible tourism around Lake Balaton.

Table 1. Good practices and challenges in the field of accessible tourism in the Balaton area

Good practice	Challenges
Barrier – free transport	
90 percent discount for travelling with Hungarian State Railways (MÁV) for people with disabilities and the person accompanying them.	Only few of the train carriages are wheelchair accessible and there is a need for careful planning in advance.
90 percent discount for travelling with the National Coach Company (VOLÁN) for people with disabilities and a person accompanying them.	Most of the coaches are inaccessible to wheelchairs.
Accessible catamaran, travelling on Lake Balaton, Siófok–Balatonfüred–Tihany line that offers barrier-free board, barrier-free toilet and special lift for people using the wheelchair.	Only one line available.
Barrier-free accommodations, restaurants and other services	
In the Lake Balaton area, they are listed in the Database http://www.hungary4all.hu/balaton-adatbazis/, prepared by Hungary4All that organizes trips for people with disabilities. Three colour codes mark the accessibility level – red, orange and green as well as contact information. The data is being constantly updated.	The information is available only in Hungarian, and is less accessible for foreign tourists.
At 7 beaches on the northern shoreline, there are special hydraulic lift-chairs and ramps available that enable access to the water.	Limited to northern shoreline.
ENAT webpage offers information on some of the Accessible Adventure tourism, sports and outdoor possibilities in the Lake Balaton area: accessible kayaking, handcycles for paraplegic people, accessible sailing boats. Further, adventure park, paintball games as well as accessible caving (with special guides) for people with disabilities are also possible (ENAT, 2020).	No challenges.
Hungary4All organises specific barrier-free trips to the Lake Balaton area for different target groups (families, young people as well as elderly people), offering various experiences, gastronomy, sports activities as well as relaxation.	No challenges.

Source: Authors' own research.

Methodology

The use of supply side oriented methods (e.g. the evaluation of the available services or official communication channels and databases) is a well-established approach in accessible tourism research. For the purpose of mapping the current status of accessible tourism at Lake Balaton and its future potential development, an exploratory quantitative survey targeted at stakeholders was employed. The Balaton Tourism Research Centre (BATUKI) at the University of Pannonia runs a tourism stakeholder survey three times per year (since 2015), which enables the collection of longitudinal and topical data from a panel consisting of representatives of municipalities responsible for tourism development, DMOs, tourism, and hospitality businesses and non-governmental organizations (NGOs). Stakeholders may share their opinions voluntary, so the number of respondents varies (between 25 and 80). A voluntary response option is used also by the other panel (e.g. UNWTO World Tourism Barometer where approximately 200 professionals participate regularly from all over the world). The *Balaton Tourism Barometer* questionnaire includes questions related to an evaluation of the past period (3 months), and the expectations for the next period (3 months). Besides the regular questions, the survey includes special sessions (e.g. cycling tourism, local products, employment in tour-

ism, overtourism, sustainable transportation, corporate social responsibility or the effects of COVID-19on tourism). The results of previous data collection efforts have been published in refereed journals (e.g. Fehérvölgyi, B. *et al.* 2019; Hajmásy, Gy. 2019; Tomej, K. 2019; Madarász, E. 2020), supporting the validation of the applied methodology. This – accessible tourism oriented – survey has been conducted during the COVID-19 pandemic, so rather than conducting personal interviews or focus group discussions, the authors decided to collect data using this panel alone.

For the purposes of this study, additional questions were drafted, aimed at exploring the perceptions of tourism stakeholders on accessible tourism in the Balaton tourism region. These questions (altogether 11 questions) were based on the conceptual framework explained in the literature review chapter (Vila, T.D. *et al*. 2015), with an adaption to the special features of Lake Balaton. The respondents were asked to evaluate (5 items Likert-scale) the 'general' accessibility of the destination and the availability for special groups. Three special segments have been identified: 1) people living with disabilities (physical, sensory, mental); 2) periodically accruing mobility problems (e.g. accident, baby carriage); and 3) groups with special needs (e.g. food allergy, elderly age groups). Services and information provided about accessible tourism were also evaluated on a 5 items Likert-scale. The survey also mapped the available accessible tourism products and services, including the information format and content about it, as well as the reasons for not offering any accessible tourism product or service. The stakeholders had also the possibility to share their views about the future development needs of accessible tourism at Lake Balaton.

A random sample of tourism stakeholders around Lake Balaton was used (based on the BATUKI's contacts). The online survey ran between 5 September and 5 October 2020, with one email reminder. Altogether 39 stakeholders participated in the research, including 11 local municipality stakeholders, 8 local destination management organizations, and 20 tourism service providers (accommodation, catering or attraction/sight). Although the sample size is limited, if one considers that the number of stakeholders involved in accessible tourism is only a small portion of the number of total tourism stakeholders, the outcomes of this exploratory research can provide a good initial point for future research. Further, in line with previous BATUKI panel surveys, the results may be considered relevant for the destination under inquiry and to some extent also for similar destinations.

The results of the survey have been analysed by using descriptive statistics. The respondents were grouped into local municipalities (public sector), destination management organisations (public sector), and service providers (private sector).

Results

Lake Balaton as an accessible tourism destination – stakeholders' perceptions

Stakeholders participating in the survey have a positive attitude towards Lake Balaton as an accessible tourism destination. Fifteen of the 39 respondents to this question agreed with the statement *'Lake Balaton is a destination that has acknowledged the market opportunity of accessible tourism, and considers it as a potential USP'*[5]. A further 14 respondents are of the opinion that *'Lake Balaton does not care about accessible tourism'*. Nine stakeholders agreed that the destination offers special services for those seeking accessible tourism, and only one service provider said that the area is an outstanding place for accessible tourism. Twenty-one of the stakeholders think accessible tourism is a necessity for Lake Balaton, while 18 other respondents think it is an opportunity.

5 In *marketing*, the unique selling proposition *(USP)*, also called the unique selling point, or the unique value proposition (UVP) in the *business model canvas*, is the *marketing strategy* of informing *customers* about how one's own *brand* or *product* is superior to its *competitors* (in addition to its other *values*).

When asking about the accessibility of Lake Balaton for certain target groups, some differences emerged. According to the stakeholders, the region is the most feasible for special needs groups (e.g. food allergy, elderly people), followed by visitors with temporary mobility problems (e.g. accident, baby carriage), and lastly for those living with a disability (physical, sensual or mental) *(Table 2*, *Figure 1).*

The survey also addressed special areas of providing an accessible tourism experience *(Table 3).* According to the participating stakeholders, Lake Balaton shows the best performance regarding tourism attractions (3.51), catering services (3.43), and information available on-site (3.39). At the same time, there is a room for development regarding the resources of local DMOs and know-how.

Transportation infrastructure together with information available online were deemed slightly better than average. It is noteworthy that in three cases (information available online, transportation infrastructure, and resources for local DMOs) the best grade given by respondents was 4 (on a 5-item scale). The various stakeholders had different views: local governments are more positive about online and on-site available information about accessible tourism. The local DMOs are the most critical about transportation infrastructure, and – not surprisingly – resources dedicated to local DMOs with the objective of developing accessible tourism. Service providers gave lower grades for catering services and tourism attractions. Improved professional knowledge and know-how would be

Table 2. Accessibility of Lake Balaton for certain segments

Segment	Mean	Standard deviation	Range (min. to max.)
Visitors living with a disability (physical, sensual or mental)	3.21	0.923	1 to 5
Visitors with temporary mobility problems (e.g. accident, baby carriage)	3.44	0.882	2 to 5
Special needs groups (e.g. food allergy, elderly people)	3.67	1.132	1 to 5

Note: 1 to 5 scale: 1 = not accessible at all, 5 = completely accessible. *Source:* Authors' own research (n = 39).

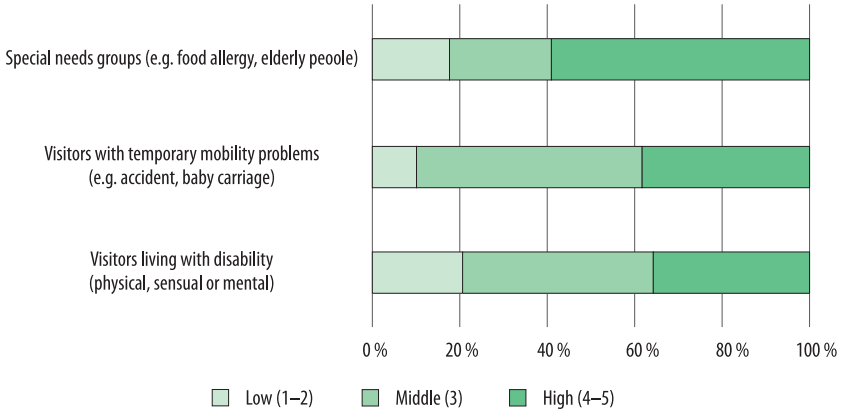

Fig. 1. Accessibility of Lake Balaton for certain segments (connecting to *Table 2*). Note: 1 to 5 scale: 1-2 = not accessible; 3 = middle value; 4-5 = accessible. *Source:* Authors' own research (n = 39)

Table 3. Evaluation of accessible tourism features at Lake Balaton

Indicators	Number of respondents	Mean	Standard Deviation	Minimum	Maximum
Information available online about accessible services	34	3.15	0.784	1	4
Information available on-site about accessible services (e.g. information office)	36	3.39	0.838	1	5
Transportation infrastructure	37	3.16	0.898	1	4
Catering services (e.g. design/ architecture, food)	37	3.43	0.899	1	5
Tourism attractions (monuments, museums, natural sights)	37	3.51	0.768	2	5
Resources of local DMOs dedicated for accessible tourism	32	2.75	1.107	1	4
Know-how, professional knowledge about accessible tourism	33	3.03	0.984	1	5

Note: 1 to 5 scale: 1 = not accessible at all, 5 = completely accessible. *Source:* Authors' own research.

welcome by all of the stakeholders at Lake Balaton. Only three respondents (all of them service providers) stated that they have human resources with dedicated know-how about accessible tourism.

Accessible tourism experiences, services offered

Sixteen stakeholders reported on accessible tourism experiences and the services offered to their guests (max. 3 services reported). The most common service was related to catering (e.g. food for guests with allergies) (7 respondents), followed by accessible design of the building/facility (6 respondents). Accessible accommodation/rooms, accessible restrooms, parking, personal information/ help, museum/attraction, transportation, website, beach, and information office were the other elements mentioned as accessible tourism services.

Respondents shared their views about the reasons for not offering accessible tourism services: lack of financial resources (13 respondents), lack of professional knowledge (9 respondents), demand is small and unstable (8 respondents), and physical, technical limitations (1 respondent).

Communication of accessible tourism experiences, services

Most of the stakeholders provided some information about accessible tourism *(Table 4).* The survey has monitored the communication channels used and the type of information content. The table below illustrates that the most 'popular' communication channels include the respondent's own website, on-site information, and own social media platforms. Brochures, information boards and on-site signposts play a less significant role in supporting accessible tourism. Brochures were highlighted only by the local municipality

Table 4. Communication channels providing information about accessible tourism

Communication channel	Number of respondents
Own website	18
On the premises of the service, product	13
Own social media	11
Information board	6
Brochure, leaflet	3
Other	1

Source: Authors' own research.

and the local DMO; none of the respondent service providers reported having a brochure with information about accessible tourism.

The information provided is mostly in text/description format (21 respondents use it), followed by photos (7 respondents) and pictograms (7 respondents). None of the stakeholders provide other types of information (e.g. plan).

Future development potential and needs

The survey also mapped the stakeholders' views about certain needs (ranking four factors) and future development options *(Figure 2).* For the involved participants, supporting factors (e.g. accessibility, infrastructure, and stakeholders' commitment) are the most important when it comes to developing Lake Balaton as an accessible destination (11 respondents ranked it as first, and 14 other respondents ranked it as second). This is followed by resources and attractions (landscape, climate, activities, culture, history, tourism service providers, and events) (1st place – 13 respondents, 2nd place – 8 respondents). Parallel with this, the quality factor (including price-value ratio, safety, perception and image), and planning and management (including positioning and branding) are among the other priorities.

As the last point of the survey, respondents were asked to share their recommendations (within an open-ended question) regarding the future development potential of accessible tourism at Lake Balaton. The most fundamental issues are financial resources (6 respondents mentioned it) and transportation (6 respondents), followed by the need for shaping attitudes of both stakeholders and travellers (4 respondents). Three stakeholders highlighted general infrastructure and beaches (the latter being a dominant product at Lake Balaton). Two of the respondents think there is a need for more accessible tourism service providers. One respondent argued for enhancing and improving accommodation options, attractions, events, and information for guests.

Discussion and conclusions

Since the perceptions, involvement and cooperation of tourism stakeholders play a key role in the potential development of an acces-

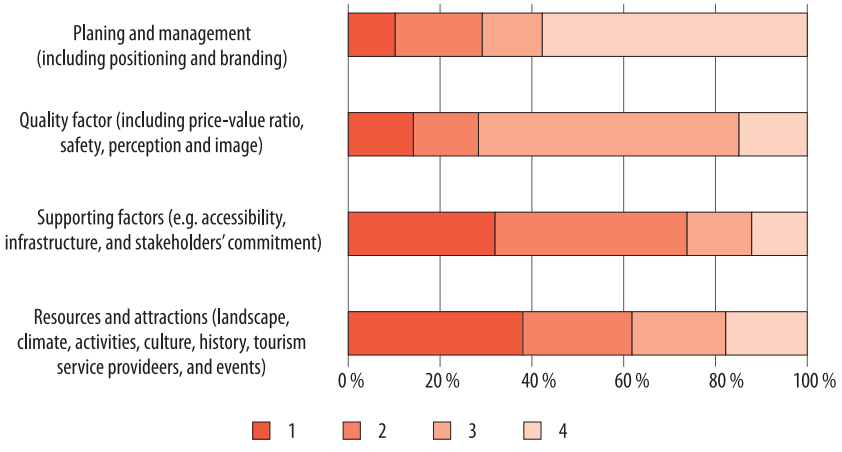

Fig. 2. Ranking of certain features, needs. Note: 1 = most important; 4 = least important. *Source:* Authors' own research (number of responses).

sible tourism destination (Kastenholz, E. *et al.* 2012), the aim of this study was to explore the views of tourism stakeholders in the Lake Balaton area. The research design was based on a literature review about accessible tourism and to a large extent on the above presented theoretical framework of Vila, T.D. *et al.* (2015).

Taking into account the exploratory nature of the study and the limitations regarding data collection, the research has valuable theoretical and practical implications. The results show that the stakeholders at Lake Balaton have a generally positive perception of destination accessibility. While the present assessment of Lake Balaton accessibility is not very favourable (with the majority of respondents claiming that the destination does not care about accessible tourism), the future position of accessible tourism is recognised as a market opportunity with a USP potential. Even if accessible service provision is poor at Lake Balaton today, as is often the case at many major travel companies (Shaw, G. and Coles, T. 2004; Bowtell, J. 2015) and many other tourism destinations (Darcy, S. 2010), the accessibility awareness and future opportunities for increasing the destination's competitiveness are recognised by a majority of tourism stakeholders. Although accessibility is integrated into numerous new developments, accessible tourism itself is still a special segment product, especially at a destination like Lake Balaton where tourism performance is dominated by another product (e.g. summer holiday at Lake Balaton).

In case of the addressed destination, accessible tourism is perceived both as a future necessity and as a future opportunity. From the public perspective, which includes the views of the local municipalities and DMOs, accessibility is understood more as a future necessity or request for destination development, which encompasses accessibility solutions that reflect the criteria of the development funds (e.g. the accessibility of new facilities). This is very much in line with the research conducted by Vila, T.D. *et al*. (2015), where destination planning and management are presented as critical factors for the development of accessible tourism provision, and as such provide the necessary foundation for accessible transport, accommodation and attraction infrastructure. From the perspective of tourism service providers, accessible tourism is recognised as a future market opportunity, despite the critical nature of the current state of accessibility at the Lake Balaton destination. All this reflects the growing number of visitors with special needs – people with temporary mobility limitations or such limitations as food allergies, so not accessible tourists with access needs in the strict sense. In practice, a wide range of service providers offer services to such travellers.

According to our research, accessible tourism attractions, catering services, online or on-site information, and transportation infrastructure are all indicators that provide evidence of physical and informational barriers that must be addressed. They are perceived as important elements in terms of the accessible tourism experience and environmental sustainability. A lack of knowledge of accessibility on the part of public and private tourism providers and the very limited financial resources spent on accessibility issues show that negative or unfavourable attitudes still exist in the tourism market, hindering the accessibility development path of the destination. For the successful development of accessible tourism, both environmental and attitudinal barriers need to be negotiated among the relevant tourism destination stakeholders. According to our research, supporting factors, such as accessibility, infrastructure and stakeholders' commitment, are the core requirements for developing Lake Balaton as an accessible destination.

In line with the literature review, the stakeholders at Lake Balaton perceive accessibility as an opportunity and a means for a sustainable future. The complexity of a destination, and so of an accessible tourism destination, is also reflected in the different views and expectations expressed by the respondents (local municipality, destination management organizations, service providers). According to the results of the survey, information pro-

vided about accessible tourism – besides infrastructure – may have an important role and may support development in an efficient way. From a practical point of view, the study identified differences between certain groups of actors that can have implications for outlining tasks and responsibilities. The concept of accessibility should include the wider phenomena, beyond travellers with mobility problems (e.g. those with food allergies), that reflect the general consumer and tourism trends, which are also seen at the selected destination, Lake Balaton.

Among the limitations of the research, low sample size and the COVID-19 effect should be highlighted, as the field work was conducted in 2020. Taking this into account, future research directions could be to extend the sample, to conduct similar studies in other destinations, and to employ other research methods like focus group discussions or interviews. An important validated outcome may be the need for a complex understanding of accessible tourism, going beyond the needs of visitors with mobility impairments and mapping the perceptions and potential roles of different stakeholder groups (in the public and private sectors).

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Uneven geographies in the various language editions of Wikipedia: the case of Ukrainian cities

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Abstract

The paper tackles the issue of uneven geographical representations on Wikipedia, the most visible and powerful user-generated encyclopaedia. In particular, it addresses language imbalances on Wikipedia with regard to geographical information and uneven spatial patterns of territory coverage on the different language versions in an attempt to verify expectations about the cultural factors that influence these imbalances and uneven spatial patterns. Ukraine is a promising case for testing the formulated expectations, as it has a large number of neighbouring countries, and most of them had political and cultural influence on its territory in the past. The volumes (word counts) of articles about the Ukrainian cities were analysed for seven language versions of Wikipedia, including the Ukrainian version and the versions of all bordering countries. The results show that historical geography is the strongest and central factor, and most of the key relic borders (former boundaries) can be traced. Ethnic composition appears to be another important factor, although weaker than the previous one. The role of the border factor is often unclear, but in some cases it definitely makes an impact and therefore cannot be completely ignored. Thus, the geographies of Wikipedia are not indifferent to the issues of ethnicity and geopolitics. The research calls into question the ability of modern Wikipedia to be a reliable and balanced source of geographical knowledge, as the described imbalances may create lopsided and biased geographical representations in people from different countries and nations.

Keywords: Wikipedia, geographical representations, uneven geographies, language inequalities, word count, cultural factors, Ukraine

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Introduction

Wikipedia is an international online project which attempts to create a free encyclopaedia in multiple languages, collaboratively and successfully edited by plenty of volunteers (Voss, J. 2005; Mamadouh, V. 2019a, b). Simultaneously, Wikipedia is a convenient and accessible source of information for millions of people around the globe. Geographical information, referring to particular places (countries, regions, cities and villages, etc.), is not an exception here. Today, when people search for information about a certain geographical location, they often use an Internet search engine, and one of the first search results will commonly be the article on Wikipedia (Lewandowski, D. and Spree, U. 2011).

However, unlike traditional encyclopaedias, the content of Wikipedia is created not by professionals but by ordinary users. Not surprisingly, the accuracy, comprehensiveness and balance of information on Wikipedia are often questioned. This applies especially to such culturally and geopolitically sensitive issues as history and geography. The worlds represented on Wikipedia are affected by those who write these representations of local places in specific languages and for specific audiences (Mamadouh, V. 2019a, b; Osborne, C. *et al.*

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2021). Although factors defining the uneven geographies on Wikipedia have been already addressed in the literature in the global dimension (Graham, M. *et al.* 2014; Dittus, M. and Graham, M. 2019; Mamadouh, V. 2019b), there is a need to tackle the issue in greater depth in relation to individual factors and regions of the globe. In this article, we leave aside the accuracy and reliability of the content of geographical representations on Wikipedia and focus instead on their spatial and language imbalances. In particular, we deal with (1) imbalances between the language versions with regard to geographical information, (2) uneven spatial patterns of territory coverage in the language versions, and (3) factors of predominantly cultural origin that influence these imbalances and patterns.

Theoretical background

Wikipedia, positioned by its creators as a free encyclopaedia, is one of the world's most visible, most used, and most powerful repositories of user-generated content (Graham, M. *et al.* 2014). At the same time, Wikipedia is one of the predominant ways in which internet users obtain knowledge about the world (Dittus, M. and Graham, M. 2019). In particular, it contains "a massive cloud of geographic information about millions of events and places around the globe put together by millions of hours of human labor" (Graham, M. *et al.* 2014). Thus, it can be asserted that Wikipedia plays an important role in the construction of geographical imaginations of various types of places in the minds of Internet users (Graham, M. *et al.* 2014; Gribok, M.V. and Tikunov, V.S. 2019).

Wikipedia is particularly interesting to cybermetric research, not least because of the richness of phenomena and full accessibility of the data (Voss, J. 2005). In particular, a large corpus of literature addresses the issues of quality and reliability of information presented on Wikipedia, giving particular attention to the fact that it can be edited by anyone who wishes to do so (Stvilia, B. *et al.* 2005; Ortega Soto, J.F. 2009; Javanmardi, S. and Lopes, C. 2010; Mamadouh, V. 2019b). Researchers have opposing opinions on this issue: from strong questioning, suspicion and disrespect by academic circles (López Marcos, P. and Sanz-Valero, J. 2013; Jemielniak, D. and Aibar, E. 2016) to conclusions about the high credibility of information in different fields of knowledge, which is ensured by multiple mutual controls of many users (Giles, J. 2005; Rosenzweig, R. 2006; Kittur, A. and Kraut, R. 2008; Mesgari, M. *et al.* 2015; James, D. 2016; Michelucci, P. and Dickinson, J.L. 2016; London, D.A. *et al.* 2019). Being by most measures the most widely read knowledge repository on Earth, Wikipedia is often treated as unworthy of academic attention (Jemielniak, D. 2019), although some opposite experiences have been already presented (e.g. Selwyn, N. and Gorard, S. 2016; Konieczny, P. 2017; Di Lauro, F. and Johinke, R. 2017).

While traditional encyclopaedias are broadly unbiased thanks to the involvement of reputable specialists, credible sources, and appropriate editorial gate keeping, it should be acknowledged that the community of Wikipedia editors (or simply Wikipedians) have also elaborated their own quality control procedures. In particular, Wikipedia is built on collective efforts and consensus seeking; the diverging viewpoints should be taken care of through deliberation and argumentation; the full history of editions and discussions is open, public, and archived. To prevent various kinds of vandalism, editors have an important role in controlling new edits and policing articles under their supervision; bots (web robots) are also involved in registering suspected activities and preventing damage to the articles. The quality assurance mechanisms also include the special statuses for distinct articles like "good articles" and "features articles" (Mamadouh, V. 2019b). However, the editorial mechanisms and standards of quality vary widely among Wikipedia projects (Jemielniak, D. and Wilamowski, M. 2017). The basic reasons are the diverging number of editors involved and

different cultural traditions regarding hierarchy and autonomy (Hara, N. *et al.* 2010; Mamadouh, V. 2019b). While the most developed versions draw on a very large number of volunteers and, consequently, a lot of reads and corrections, less developed versions usually depend on a few (but very active) volunteers. Some versions (e.g. Volapük and Cebuano) have expanded dramatically using machine translation through the work of bots generating articles by translating them automatically from the other Wikipedias, although the value of such articles is questioned by some Wikipedia editors who prefer quality to quantity (Mamadouh, V. 2019b).

Geographic representations on Wikipedia are not an exception; they greatly depend on their creators and audiences, and therefore they are asymmetric and biased both spatially and in terms of content. Graham, M. *et al.* (2015), addressing this issue, distinguish uneven geographies of access, participation, and production. The most typical phenomenon is a self-focus bias (Hecht, B. and Gergle, D. 2009, 2010a, b), when "articles about places, people, and events where the language of the edition was spoken were more prominent than those in other regions" (Hale, S. 2014, 99). This is one of the reasons why different language versions of Wikipedia have different quality of coverage with regard to specific regions of the globe. Consequently, the most prominent articles about local places and events are often (but not always) written in local languages (Sen, S.W. *et. al.* 2015; Kim, S. *et al.* 2016).

At the same time, in many parts of the world, socioeconomic realities and digital divides constrain participation in Wikipedia editing (Dittus, M. and Graham, M. 2019), which causes numerous exceptions to the rule. A significant number of people are being excluded from the collective process of knowledge production due to technical, social, economic, political, regulatory, and infrastructural barriers that arise often solely on the basis of their native language (van Dijk, Z. 2009; Friedman, U. 2016; Osborne, C. *et al.* 2021). That is why the geography of articles related to the geographical places is highly uneven and clustered in developed countries, and simultaneously, large areas of the developing world remain invisible (Graham, M. *et al.* 2014). For example, there are more geotagged articles in the Netherlands than in Africa as a whole (Graham, M. *et al.* 2014). In the global context of today's digital knowledge economies, these digital absences are likely to have very material effects and consequences (Graham, M. *et al.* 2014). Similarly, the analysis of timelines of national histories across Wikipedia language versions showed that narratives about national histories are distributed unevenly across the continents with a significant focus on the history of European countries. Also, national historical timelines vary across language editions, although average inter-lingual consensus is rather high. In this sense, Wikipedia's historical reference articles are not free from gaps and biases (Samoilenko, A. *et al.* 2017).

Furthermore, the uneven involvement of people from different countries and regions in the editing of Wikipedia contributes to the language imbalances: some languages are overrepresented, while some other are represented more than modestly (Dittus, M. and Graham, M. 2019). Especially this refers to the dominant position of English, currently being the most powerful global language and de-facto standard language of the Internet (Danet, B. and Herring, S.C. 2007). It has been shown that for many countries in the Global South, which includes Africa, Asia, and South America, there are more articles written in English than in the respective native languages (Graham, M. *et al.* 2014; Dittus, M. and Graham, M. 2019).

Research expectations

Relying upon the literature (Graham, M. *et al.* 2014; Kim, S. *et al.* 2016; Dittus, M. and Graham, M. 2019; etc.), we assumed that articles on Wikipedia about geographical places are written mainly by three groups of authors: (1) locals who have knowledge

about the place, as well as strong physical and/or mental attachment to it, and want to convey this knowledge to a wide range of users, (2) people that are not locals but who are interested in the particular place due to the cultural ties shaped by the national, cultural, professional identity, etc., and (3) specialists in one topic (for example geography, history, etc. of cities or regions) that are not particularly interested in a specific city. Also, to contribute to a specific language version of Wikipedia, the author must be proficient in the respective language, and articles in such a language will be targeted primarily at the speakers of respective language, and therefore will be devoted to those places and aspects that are of interest to these speakers. On the other hand, the audience is important: people living in a city/region/country usually need more detailed information about that place than people living far away; the Wikipedia community does not promote the translation of articles without localization in the societal context associated with the language to serve the intended audience (Mamadouh, V. 2019b). Thus, it is assumed that each of the Wikipedias is focused primarily on geographical places that are related to the geography, history and culture of the respective nations and countries.

Taking into account the abovementioned remarks, we formulated three research expectations. The first expectation is that there should be a correlation between the ethnic/linguistic composition of the population of a given place and the size of article in the respective language version of Wikipedia about this place. The second expectation is about the positive correlation between the distance from a given place to the border of the country and the size of articles in the respective language version of Wikipedia about this place. The third expectation implies that places that sometime in the past where under the political and cultural influence of a particular state or ethnic group should be more widely represented in respective Wikipedia than the places having no common political and cultural background.

Data and methods

Ukraine is a promising case for checking the outlined expectations. It borders a large number of neighbouring countries, and in the past its territory has been under their political and cultural influence. Among the countries having land borders with Ukraine, only Belarus and Moldova have never politically controlled a part of Ukrainian state territory (in this context, we refer not to modern states but to their predecessors). Also, Ukraine is not a mono-ethnic state: sizeable national minorities live on its territory, including titular ethnic groups of neighbouring countries.

We analysed six versions of Wikipedia in the official languages of countries that have a land border with Ukraine, in particular the Russian, Polish, Romanian, Belarusian, Hungarian and Slovak versions. The Ukrainian version was covered by the study as well. It is important to keep in mind that these are language versions and not national versions, and therefore they are serving not only people from the respective countries but the whole language audiences. In this way, the Polish version serves a Polish audience, concentrated predominantly in Poland, of which the ethnic Poles in Ukraine are a tiny minority; the same applies to the Hungarian and Slovakian versions. On the other hand, the Russian version serves a transnational audience of Russian speakers across the world, especially from the former Soviet Union countries (not only Russians in Russia or Russian speakers in Ukraine), while the Romanian version of Wikipedia now serves principally the Romanian-language audience in both Romania and Moldova. The separate Moldavian Wikipedia in Cyrillic alphabet was closed because the Moldovan language was found to be a version of Romanian (even according to the 1989 Language Law of Moldova), and there is a software to navigate the two scripts (Mamadouh, V. 2019a). Regarding the Belarusian version, it may be supposed that it is principally serving nationally minded Belarusians all over the world,

while the majority of people in Belarus prefer the Russian version as it is better understood and more developed. Finally, the Ukrainian version serves not only the audience in Ukraine, but the vast Ukrainian diaspora.

Among all the geotagged articles related to geographical places in Ukraine, we focused on the articles about the cities. In this manner we clearly defined and shortened the list of scrutinized articles. At the same time, today's human activities are mostly tied to cities, and public representations about countries and regions are often constructed under the lens of urban geographies. In total, articles about 457 cities were analysed. As a rule, the content of the articles includes information blocks on the city's site and situation, physical geography (relief, climate, soils, flora, fauna, etc.), history, contemporary demographics and economic development, culture, transport, social sector, landmarks and prominent personalities, etc.

The key analysed parameter was the volume of an article, defined as a word count of the main text, including the captions of the illustrations and the lists of notes and references, but without the side inserts. When the article about a particular city is absent, the volume of the article is equated to 0 (zero word articles). Here we supposed that the volume of the article correlates with the amount of information contained in this article, thus, being indicative of the potential usefulness of the article for readers, i.e. the difference in word counts translates into differences in quality. The objection here could be the fact that the volume of the article depends on the city's size: the bigger a city, the larger the expected volume of the article. However, this rule is neither strong nor linear (cf. Gribok, M.V. and Tikunov, V.S. 2019), and the dependence function varies between different language versions of Wikipedia. That is why we decided to avoid the use of relative indices, such as ratio of the article volume to the city population, but to supplement the main parameter with two additional ones. First, the mean volume of the article for each language version was calculated for administrative regions of Ukraine (regions and main cities are shown in *Figure 1*; Crimea was 'de facto' annexed by the Russian Federation in 2014 but is claimed by Ukraine and recognized as Ukrainian by the United Nations, affirming the territorial integrity of Ukraine within its internationally recognised borders, and by most other countries). In this way the fluctuations in article volumes for cities of different sizes were smoothed out within the regions, and general trends could be seen more easily. Second, the rank of the articles by volume among the seven analysed language versions was defined for each language version. This means that for each specific city, the language version with the largest volume of the article received the 1st rank, the next – the 2nd rank, and so on until the language version with the smallest article that received the 7th rank (zero word articles were subjects for ranking as well, being assigned the 7th rank). Here the absolute size of the article is substituted with the ratio of the volume of different language versions of the same article, and in this manner articles about cities of different size may be compared. Also, the ranking approach makes visible the relationship between language versions for particular cities or regions, often revealing subtle but important trends and differences. Thus, the ranking was used (1) to show disproportions between the different language versions in the national dimension, and (2) to reveal the uneven relationship between language versions in the regional dimension.

The obtained patterns were compared with the factors that may influence the situation according to the initial expectations *(Figure 2).*

First, the factor of ethnicity: the share of the respective ethnic groups in each administrative region is shown in the form of cartograms. The data are taken from the 2001 census; for the Romanian language, cumulative share of Romanians and Moldovans is shown. It is expected that the higher share of a particular ethnic group in a city/region should correspond to more extensive articles on the respective Wikipedia, because of a larger number of local Wikipedians.

Fig. 1. Administrative territorial division of Ukraine and main cities. Notes: Administrative centres of the regions are written in capital letters. The names of the regions correspond to the names of their centres except for Volyn region (centre in Lutsk), Zakarpattia region (centre in Uzhhorod) and Crimea (centre in Simferopol). The Crimea was annexed by Russian Federation in 2014, but is claimed by Ukraine and recognized as Ukrainian by the United Nations. Kyiv and Sevastopol are the cities of the special status (equated to the regions), and the city of Slavutych is an exclave of the Kyiv region. For this research they were counted as belonging to Kyiv region, the Crimea, and Chernihiv region respectively.

Second, the factor of historical geography: hatching denotes areas controlled by the respective states in the past. For the Slovak language, the area controlled by Czechoslovakia in 1920–1939 is shown. For countries such as Russia and Poland, different types of hatching show gradations of impact. In particular, for Poland these are the territories controlled by the Second Polish Republic (1921–1939) and by the Polish-Lithuanian Commonwealth (from the 15th century to 1792), and for Russia the lowest level of influence was determined for the regions of Western Ukraine annexed to the USSR only after 1939, the high level for the left bank Ukraine (obtained by Russia under the Truce of Andrusovo in 1667), the Black Sea region (densely settled during the Russia-led colonization in 18–19th centuries), and the highest level for Crimea (transferred to the Soviet Ukraine only in 1954 and annexed by the Russian Federation in 2014). It is expected that cities/regions with such historical ties to other countries should be of greater interest to the Wikipedians from these countries. This factor has no sense for Ukrainian Wikipedia or, indeed, for the Belarusian one as the Belarusian state has never owned any part of the contemporary Ukrainian territory.

Third, the factor of a border: the maps show the borders with respective countries. For the Romanian language, the borders of Romania and Moldova are shown; for the Russian language, the borders of the Russian

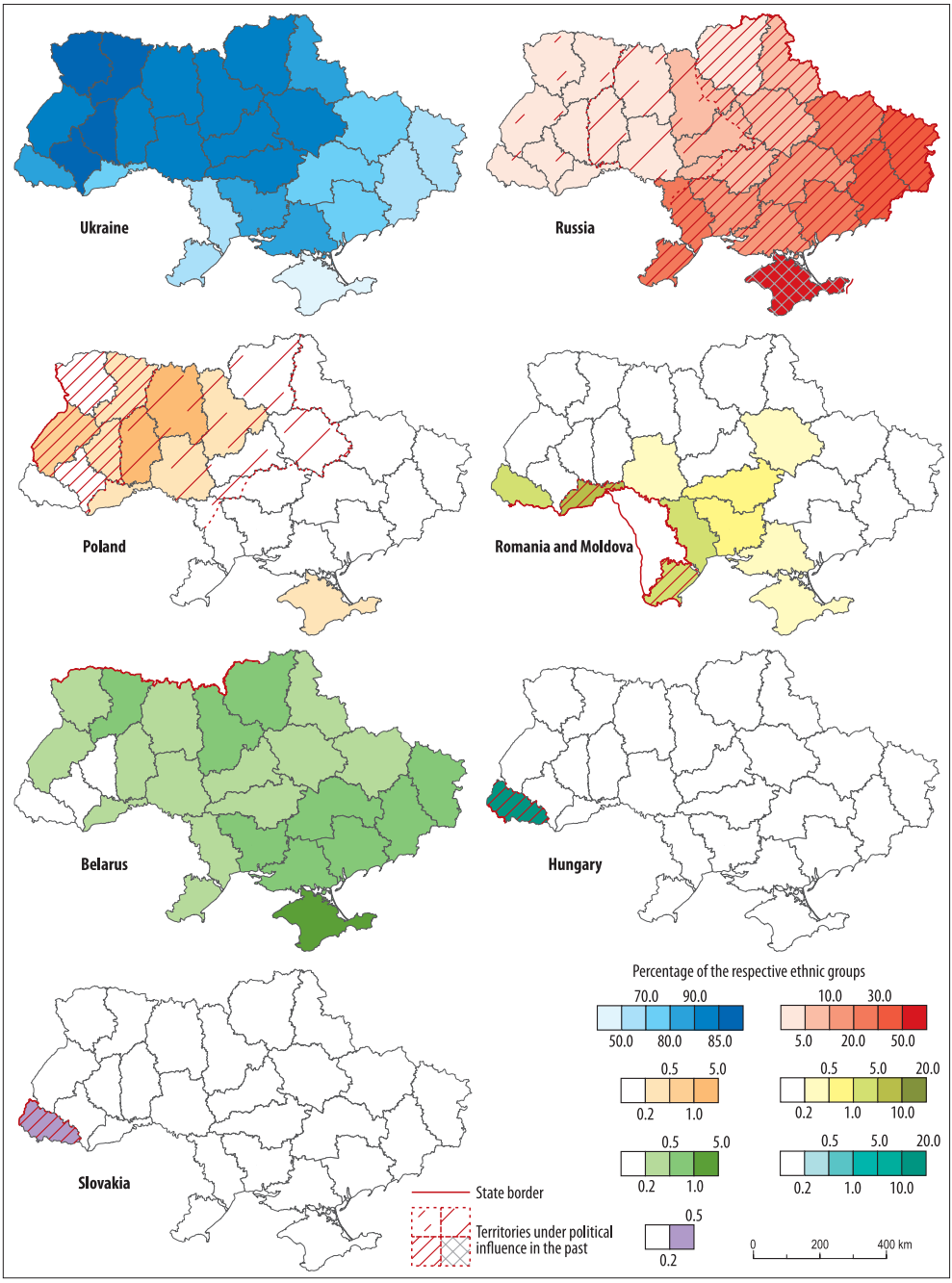

Fig. 2. Factors that potentially influence geographical representations on Wikipedia

Federation and Transnistria (Pridnestrovian Moldavian Republic) are shown. The expectation is a higher level of interest among Wikipedians living in each bordering country in nearby cities/regions of Ukraine (compared to the more distant ones).

It is worth remembering that these factors mostly are not fully independent: the ethnic structure often is shaped by the historical geography, and the border areas are often settled by the respective ethnic group or were controlled in the past by the neighbouring state. Also, some other factors may influence the representations on certain language versions, such as the size (and number of editors) of a particular version of Wikipedia, the use of bots-generated or translated content, and huge ethnic diasporas.

Results and discussion

The further analysis is divided into two subsections. In the first subsection, we discuss the revealed imbalances of representation between the language versions of Wikipedia in the national dimension, leaving aside the differences between the regions. In the second subsection we consistently consider each language version, focusing on the interregional differences in representation, as well as on the interregional variations in the relationship between language versions (using the ranking). At the end of this subsection, the results are compared with the initial research expectations. The results in terms of the research parameters are shown in *Figures 3, 4,* and *5.*

General imbalance between the language versions

The first important observation is a substantial imbalance in the coverage of Ukrainian cities by the studied language versions of Wikipedia (see *Figures 3, 4* and *5*). The basic statistical parameters are given in the *Table 1*: mean, median, maximal and minimal values of the volume of article (in words). Also, the coefficient of variation (CV) has been calculated for the volume of articles for each language version to assess the uniformity of the representation of cities: the lower the CV, the higher the observed uniformity, and vice versa. The last two columns show the percentage of cities with articles of less than 100 words (which can be considered uninformative) and the percentage of the cities with no article at all (zero word articles).

It is seen from the table that the longest articles are typical of the Ukrainian and Russian versions. Also, these language versions show the lowest coefficients of variation, which means that all cities across the country are more or less evenly reflected; in particular, there are no articles shorter than 100 words and there are no cities without an article. The leading position of the Ukrainian and Russian versions is explained by the leading role of the respective languages: Ukrainian is the official and the most widespread language; Russian takes the second place by the number of speakers, and it is still widely used as the lingua franca in the post-Soviet space. They are followed by the Polish and Belarusian versions with medium volume of articles, greater variation of values and a certain percentage of very short articles (less than 100 words). Although articles in Romanian are available for almost all cities, a high proportion of articles contain less than 100 words. This means that the vast majority of these articles are uninformative. Interestingly, most of such uninformative articles have been created by bots using the standardized template. The less elaborated are the Hungarian and Slovak versions: if all cities are taken into account, they have the lowest average volume of the articles, and only circa 20 percent of cities are reflected in these language versions. However, if we narrow the view to the actually existing articles (excluding zero volume articles), their average volume will be comparable to the Romanian and Belarusian versions. This means that while the Romanian Wikipedia provides limited information but on merely every city, the Hungarian and Slovak versions contain sufficiently expanded

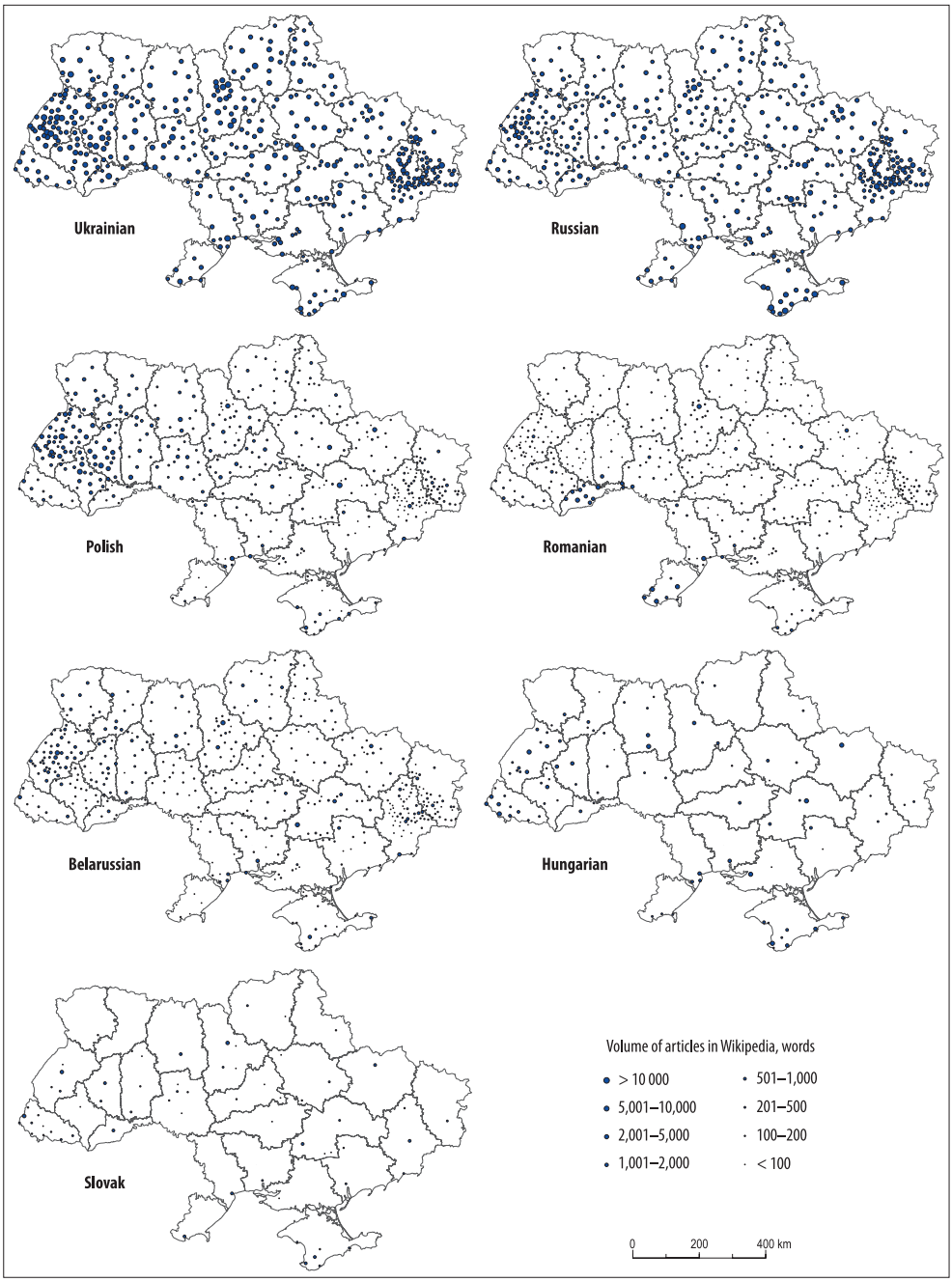

Fig. 3. Volume of the articles about cities on Wikipedia

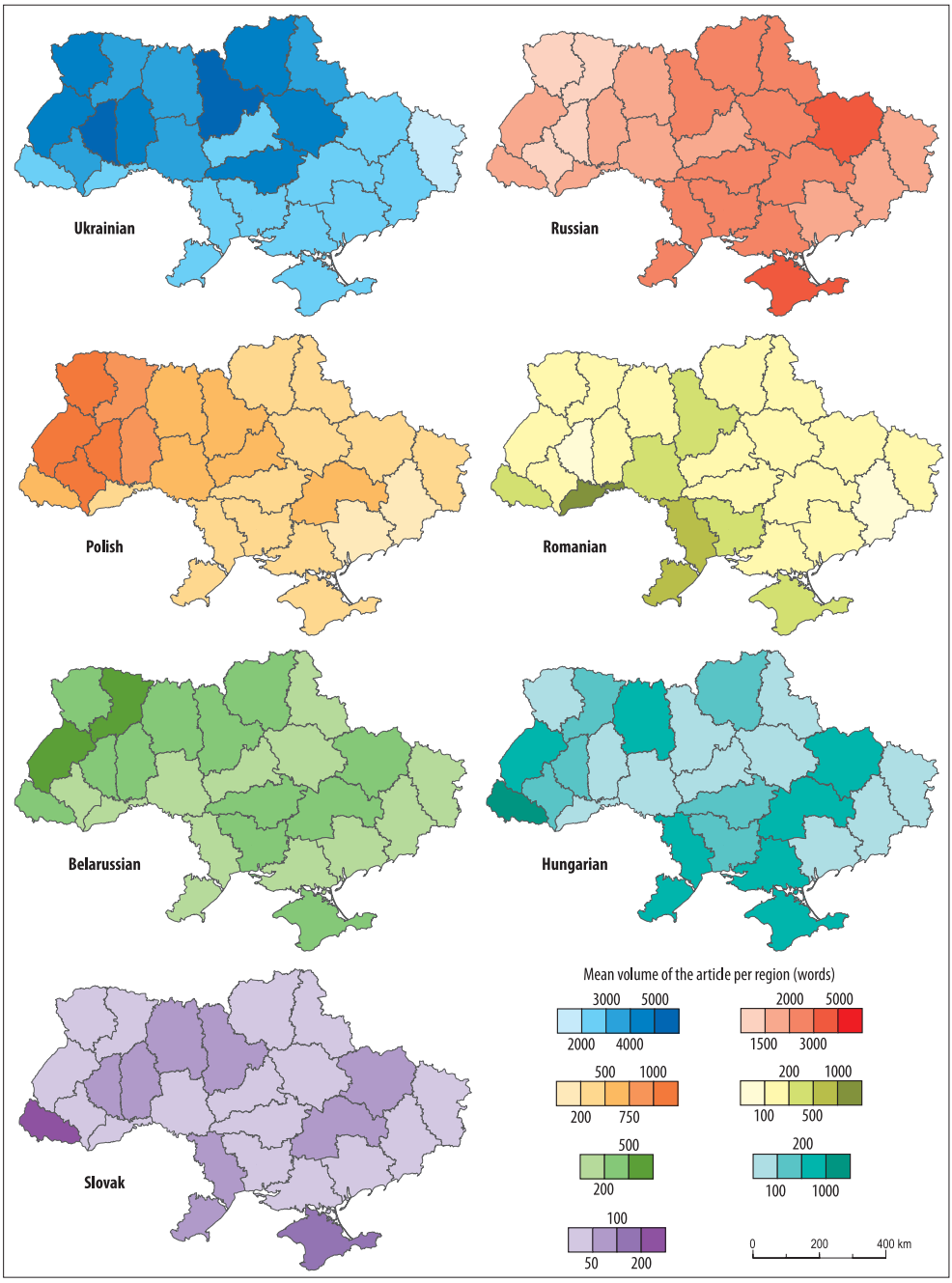

Fig. 4. Mean volume of the articles about cities on Wikipedia

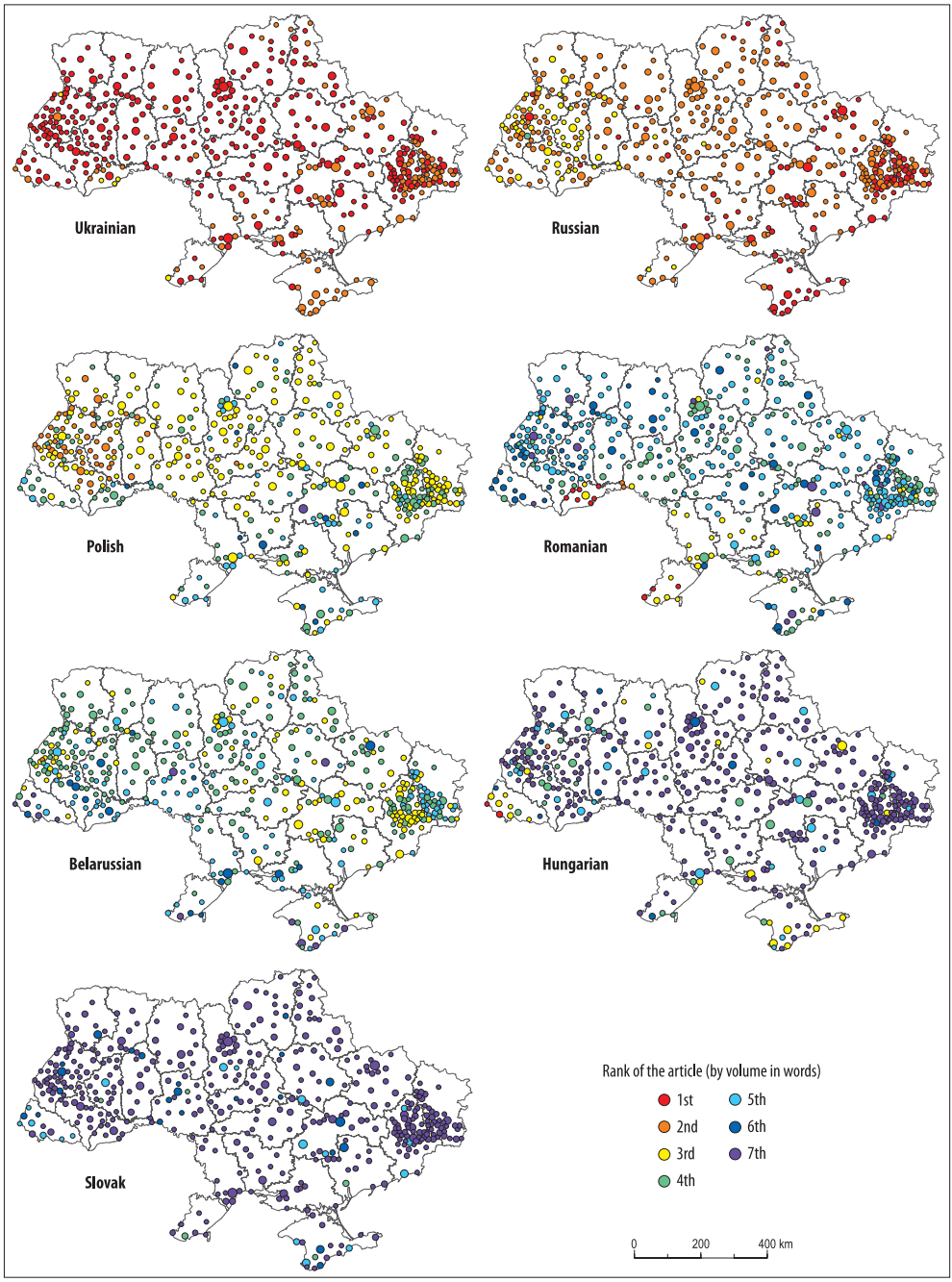

Fig. 5. Rank of the articles about cities on Wikipedia

Table 1. Article statistics for the language versions of Wikipedia

Language	Mean	Median	Max	Min	CV	V < 100, %	V = 0, %
Ukrainian	3,424	2,339	21,161	254	0.89	0.0	0.0
Russian	2,072	1,351	16,195	179	1.11	0.0	0.0
Polish	591	257	12,798	9	1.68	15.8	0.0
Belarusian	269	157	2,436	0	1.13	18.4	0.0
Romanian	206	113	3,869	8	2.08	34.6	1.8
Hungarian	157	0	4,791	0	3.31	81.0	79.6
Slovak	43	0	1,265	0	3.46	89.1	85.3

information (contributed by the human editors rather than bots) but for a smaller group of cities. The distribution of ranks leads to similar conclusions.

The overall size of the different Wikipedia versions varies greatly, so it is to be expected that the larger ones feature more information (also about Ukrainian cities) than the smaller ones. In reality, the described differences of representation do show clear a correlation with the size of these versions. In particular, the Russian Wikipedia has 1,700,000+ articles, Polish – 1,400,000+ articles, Ukrainian – 1,000,000+ articles, Hungarian and Romanian – 400,000+ articles, Slovak and Belarusian – 200,000+ articles. The most obvious differences are the better positions of Ukrainian (because it is the official and native language for the majority of Ukrainian citizens), Belarusian (probably due to the common post-Soviet context and the ease of translation from Ukrainian or Russian), and Romanian (due to the extensive use of bots for the creation of articles) versions. The positions of the Russian and Polish versions may have been further strengthened by the sizeable Ukrainian diasporas in these countries.

The findings suggest that people from different nations who choose Wikipedia in their native language as a source of geographical knowledge will have different opportunities to access knowledge about a specific area. Not only will users of some language versions receive less information about the same geographical location, but also most of the places will simply not exist for them (cf. Graham, M. 2009 on virtual "terra incognita"). This calls into question the usefulness of present-day Wikipedia as a source of geographical knowledge – at least for certain language versions and for certain territories.

Uneven geographies of representation on the language versions

Besides the general imbalances between the studied Wikipedias, each of them has specific territorial imbalances of coverage within the country, and most of these spatial patterns fit one or more initial research expectations.

Although the correlation between the share of ethnic Ukrainians and the mean volumes and ranks of the articles in the Ukrainian Wikipedia is not strong, both maps *(Figures 1* and *4)* clearly show the same fault line between the west and centre of the country, where the proportion of ethnic Ukrainians is higher than 80 percent, and the rest of the country, where this proportion is less than 80 percent (the only exception is the Cherkasy region with a high share of ethnic Ukrainians but shorter articles in the Ukrainian Wikipedia). Also, Ukrainian-language articles rank almost exclusively 1st to the West and North of this fault line, while they often rank 2nd or even 3rd to the East and South of it. The extreme case in this regard is Crimea, where the article in Ukrainian ranks 1st for only one city. This fault line is well known to researchers addressing issues of Ukrainian geopolitics, in particular electoral patterns (Osipian, A.L. and Osipian, A.L. 2012; Diesen, G. and Keane, C. 2017). Although the current differences in the share of ethnic Ukrainians are themselves determined by ancient geopolitical and natural boundaries, Wikipedia's content is

directly influenced by the modern ethnic composition of the local editors, and therefore we consider the described pattern as evidence of the ethnic factor's influence.

In the Russian Wikipedia, the highest volume of articles is observed for Crimea, the region with the most powerful political and cultural ties with Russia (and where Russians are a dominant ethnic group). It is followed by the Black Sea region (where both ethnicity and historical geography are major factors) and the northern part of the left-bank Ukraine (where the factor of historical geography is the most important). The lowest volume of articles is observed in the regions of Western Ukraine that were annexed by the Soviet Union after 1939 *(Figures 3* and *4).* Russian-language articles rank 1st in Crimea (except for Yevpatoria), interchangeably 1st or 2nd in the other regions of the south-east and in the extreme north-east, predominantly 2nd in central Ukraine and mainly interchangeably 2nd and 3rd in that part of Western Ukraine annexed by the Soviet Union after 1939. An especially low rank of the Russian-language articles is observed in the Galician regions (Ternopil, Ivano-Frankivsk, Lviv), which together with the Zakarpattia and Chernivtsi regions were not controlled by the Russian Empire *(Figure 5).* The influence of ethnicity and borderline factors can also be traced, but to a much lesser extent.

The mean volume of articles in the Polish Wikipedia decreases with increasing distance from the Polish border – from the west to the south-east of Ukraine. A more detailed look reveals the influence of historical geography. In particular, the eastern border of the Second Polish Republic (which included contemporary Lviv, Ivano-Frankivsk, Ternopil, Volyn and Rivne regions) is still visible on the maps *(Figures 3*, *4* and *5)*: the mean volume of articles here generally exceeds 1,000 words, and many articles have the 2nd rank, overtaking the Russian version. This is especially true for the three Galician regions, where Polish articles rank 2nd for more than half of the cities. The influence of the Kingdom of Poland and the Polish-Lithuanian Commonwealth can also be observed, although less obvious at first glance. In particular, a significant decrease in the volume of articles takes place with the transition of the Dnieper, i.e. from the right-bank to the left-bank Ukraine *(Figures 3* and *4)*, that is west of the former eastern border of the Commonwealth *(Figure 2).* However, it is important to remember that the map *(Figure 2)* shows the most eastern position of the border, but after the Truce of Andrusovo (1667) it generally passed along the Dnieper, and the right-bank Ukraine has been under Polish political influence for a longer time than the left-bank Ukraine. On the contrary, those areas of Western Ukraine that have not been under Polish rule (the Zakarpattia and Chernivtsi regions) are less covered by the Polish Wikipedia both in terms of volume and rank of the articles. Although the area that is best covered by the Polish Wikipedia generally overlaps with the area with the highest proportion of ethnic Poles, the factor of ethnicity is clearly not the crucial one here. If this were the case, we should have expected the best coverage in the Zhytomyr and Khmelnytskyi regions, which are home to the largest number of Ukrainian Poles.

In the Romanian Wikipedia, two territories are clearly distinguished against the general background: the Chernivtsi region and the southern part of the Odessa region within the historical area of Bessarabia. Here, the mean volume of articles is approximately 10 times higher than the average values across Ukraine *(Figures 3* and *4).* The average rank of the articles in Romanian is also significantly higher than in the rest of the country. In particular, the Romanian Wikipedia ranks first for the majority of cities in the Chernivtsi region and for three among 19 cities in the Odessa region; the minimum rank of Romanian Wikipedia in these areas does not fall below the 3rd *(Figure 5).* Both of these territories were controlled by the Principality of Moldavia from the 14th to 18th centuries, and by Romania in 1918–1940 and 1941–1944, and have the highest proportions of the Romanian/Moldovan population in Ukraine.

At the same time, the rather high share of Romanians in Zakarpattia is not accompanied by such a significant increase in the volume of articles, although Transcarpathia also boasts in terms of the Romanian Wikipedia more articles than do the other regions. The other Ukrainian territories with a relatively high share of Romanians/Moldovans, including the Mykolaiv and Vinnytsia regions, Crimea and so forth also typically show higher volumes and ranks of articles in the Romanian Wikipedia; however, this correlation is not very strong. The influence of Romanian/Moldovan border is debatable: on the one hand, the majority of regions bordering Romania/Moldova have better representations of the cities in Romanian Wikipedia compared to the rest of the country, but on the other, the Ivano-Frankivsk region (which has no significant Romanian/Moldavian minority and has never been controlled by the Romanian or Moldovan state) breaches the rule. Thus, for the Romanian Wikipedia, the historical geography factor is most important, followed by the factor of ethnicity, and the influence of the border factor is only in third place and is of questionable significance.

Belarus has never politically controlled any part of Ukraine. Thus, in the case of the Belarusian Wikipedia, we can ignore the factor of historical geography and take a closer look at the two other factors: border and ethnicity. Three groups of regions have a relatively better representation in the Belarusian Wikipedia: (1) Western Ukraine, (2) the regions near the Belarusian border (in the northern part of Ukraine), and (3) the regions of the southeast of Ukraine *(Figure 4).* The same three groups of regions are distinguished in the terms of ranks *(Figure 5).* The second group may be explained by both the higher share of Belarusians in the population and the direct proximity to the Belarusian border *(Figure 2).* The third group is distant from the Belarusian border, but the share of ethnic Belarusians is the highest in these very regions, therefore the factor of ethnicity may be an explanation here. However, the good representation of Western Ukraine in the Belarusian Wikipedia cannot be explained by the considered factors; probably, Western Ukraine, especially the Lviv region, is interesting for a Belarusian audience as a vibrant touristic area. Another possible explanation for the interest of Belarusian Wikipedians in Western Ukrainian cities could be an inspiration to strengthen their national language against Russian.

As for the Hungarian and Slovak Wikipedias, the interregional differences in the volume of actually existing articles are not so impressive *(Figure 3).* However, Zakarpattia (Transcarpathia) is the only region where absolutely all cities have their articles in these language versions. If we consider that most cities in Ukraine have no Hungarian and Slovak articles at all (i.e. their volume is equated to zero), Zakarpattia will stand out sharply against other regions in terms of the average volume of articles *(Figure 4)*. The same applies to ranks *(Figure 5).* While in the other regions the Hungarian Wikipedia most often ranks 7th (sometimes 5–6th, very seldomly 4th or 3rd), in Zakarpattia two cities have the 1st rank, and six cities – the 2nd rank (out of a total of 11 cities). Similarly, while in the other regions the Slovak Wikipedia is often ranked 7th (sometimes 5–6th, very rarely 4th), in Zakarpattia, six out of 11 cities have 5th rank. This result is perfectly consistent with the historical geography of Zakarpattia, as it was for many centuries a part of the Hungarian state (from the 11th century until the Treaty of Trianon in 1920, and also in the World War II period of 1939–1944) and was a part of Czechoslovakia in the interwar period (1920–1939). It should also be noted that the political influence of Hungary and Czechoslovakia has never spread to any other region of Ukraine. Zakarpattia is also the only region bordering modern Hungary and Slovakia and having a significant representation of relevant national minorities. However, the favourable positions of the Hungarian and Slovak Wikipedia are observed for the entire Zakarpattia region, not only for those parts that lay closer to the respective state borders; also, there are no signs

of better elaborated Slovak articles in the southwest of the Lviv region, which is very close to the Slovak border. Another observation is the absence of a strong correlation between the number of ethnic Hungarians and Slovaks and the mean volumes and ranks of the Wikipedia articles across the other Ukrainian regions. That is why, for both language versions, we may consider the historical geography factor to be the central one, the factor of ethnicity to be also influential, although less important, and the border factor as less significant and rather unclear.

The estimated influence of all three studied factors is summarized in *Table 2*.

The table shows that the factor of historical geography is the strongest and the central one, as its influence is clearly traced in all five cases when this factor is relevant. The factor of ethnicity appears to be also important, although weaker than the previous one. Finally, the role of the border factor is often unclear; in two cases it is estimated as weak, and only in one case (the Belarusian Wikipedia) as strong. Interestingly, this is the exact case when the historical geography factor is eliminated. Therefore, although the border factor cannot be completely ignored, we can definitely assert its relative weakness compared with the other two factors.

Nevertheless, these factors to a greater or lesser extent may contribute to the uneven geographical representations in the linguistic versions of Wikipedia. That means that people from different nations, using Wikipedia in their native language as a source of geographical knowledge, are receiving uneven spatial representations of the real world. For example, Poles, being well informed about Western Ukraine, receive limited information about the south-eastern part of the country, and for Slovaks or Hungarians the vast majority of the country, with the exception of a few islands, will be "terra incognita". Given the nature of the factors considered, this applies in particular to neighbouring countries/nations/cultures having a complicated history of mutual relationships, including territorial exchanges in the past. The geographies of Wikipedia are not indifferent to nationality and geopolitics; they are mirroring ethnic identities and exhibit phantom boundaries no worse than the election results.

Conclusions

The research shows the uneven geographical representation of Ukrainian cities on Wikipedias written in the official languages of countries bordering Ukraine, as well as in the Ukrainian Wikipedia. The revealed patterns are well explained by the two factors: historical geography (the strongest one) and ethnicity (less strong). The third presumed albeit ambiguous factor is the distance to the border of the respective country. Also, the study documented significant disproportions in the amount of information between the language versions caused, first of all, by the differences in their size (and, respectively, the number of active editors). However, a shared recent history (e.g. the common experiences of Ukraine, Russia and Belarus in

Table 2. Influence of factors on the language versions of Wikipedia

Language	Ethnicity	Historical geography	Border
Ukrainian	strong	not relevant	not relevant
Russian	weak	strong	weak
Polish			
Belarusian	strong	not relevant	strong
Romanian	weak	strong	unclear
Hungarian	strong		
Slovak			

the post-Soviet space) and contemporary social and cultural ties (e.g. the presence of large Ukrainian diasporas in Poland and Russia) contribute to the better representation of Ukrainian urban geography on the respective Wikipedias. The editorial policies and mechanisms of different Wikipedias are important as well, as shows the example of Romanian Wikipedia ballooned via the use of bots-generated geotagged articles.

Jemelniak, D. (2019) expressed a hope that "in 2019 Wikipedia turned 18, so maybe academics should start treating it as an adult". However, nowadays language versions of Wikipedia often behave like disengaged, discordant and obsessed teenagers. Our research confirmed the risk that Wikipedia "might not just be reflecting the world, but also reproducing new, uneven, geographies of information" (Graham, M. *et al.* 2014). The different language versions of Wikipedia, taken separately, constitute neither objective nor impartial sources of information. Even being based on purely quantitative research methods and leaving aside the content-related issues, our research calls into question the ability of Wikipedia to be a reliable and balanced source of geographical knowledge. The imbalances and uneven spatial patterns create lopsided and biased geographical representations in people from different countries and nations, which in the conditions of modern information society may have negative economic and social effects. Further research is required in this field before the next step can be taken with a switch to the biases in content, reflecting the subjective view of the Wikipedia editors and audiences – the bearers of a certain cultural traditions, geopolitical ideas and representations about the 'true' versions of history and, consequently, geography of the own country and the surrounding world. The edit wars on Wikipedia, reflecting controversies with regard to the selection and rendering of historical periods and current affairs, are another promising topic for further research, particularly in the geopolitically divided country that Ukraine currently represents. The first shoots of such academic investigations (see e.g. Rogers, R.A. and Sendijarevic, E. 2012; Jemielniak, D. 2014; Kumar, S. 2017; Kopf, S.E. 2018) need further development.

Billions of people do not have access to free knowledge, and expanding the corpus of knowledge on Wikipedia is an effective way to feel this gap (Jemielniak, D. 2019). Thus, Wikipedia editors, including representatives of academia, must try hard to overcome the imbalances and to substantially improve Wikipedia's quality with regard to geographical representations.

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Inspecting map compilation in earth sciences for better communication

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Abstract

The use of thematic cartography in earth sciences is a frequent task for researchers when publishing. When creating a map, researchers intend to communicate important spatial information that enhances, supplements or replaces textual content. Not only visual but substantial requirements exist for those who create maps. Cartographic visualisation has several well-established rules that must be taken into account during compilation, but not all researchers apply them correctly. The present study aims to identify the factors determining the quality of geoscientific maps and what needs to be improved during a map compilation process. To get to know the tendencies, we have investigated maps in designated journals – one Hungarian and one international per earth science branch: geography, cartography, geology, geophysics, and meteorology. A system of criteria was set up for evaluating the maps objectively; basic rules of cartography, quality of visual representation, and copyright rules were investigated. The results show that better map quality is connected to journals with strict editorial rules and higher impact factors. This assessment method is suitable for analysing any kind of spatial visual representation, and individual map-composing authors can use it for evaluating their maps before submission and publication.

Keywords: thematic mapping, cartography, data visualisation, earth sciences

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The role of cartography in earth sciences

Visual processes using cartographic methods have an essential role when publishing different kinds of spatial data. Maps are important supplementary materials of scientific results, according to DiBiase, D. (1990). They can be used when analysing data, giving conclusions, or presenting outcomes. Cartographic visualisation is considered as an integral part of scientific research that can open the gates of science towards a larger audience as well (Philbrick, A.K. 1953; DiBiase, D. 1990; Robinson, A.H. *et al.* 1995).

In geoscientific research, a map has different meanings for the mapmaker and the map reader. The mapmaker works with the map, he/she uses spatial data to analyse, explore and evaluate the observed phenomena, and finally to present the results to the peers. A map reader from the scientific community sees only the representation (the final map) without going through the process of the spatial analysis. However, a researcher must aim for the reproducibility of the research when publishing the results, so the map should represent as much as possible from the process as well. The process and different purposes of map (or spatial data) use were visualised as a cube model by MacEachren, A.M. (1994), where the role of maps changes according to the task, the frequency of inter-

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actions and the type of the users *(Figure 1)*. In this model, the cognitive process of geoscientific research, which uses maps/spatial data, is represented as the body diagonal.

The third dimension (user types) of the cartographic cube is essential in presenting scientific results – the audience can interpret the researcher's message only this way (MacEachren, A.M. and Ganter, J.H. 1990; MacEachren, A.M. 1994). Furthermore, when a map is published as a representation of the results of research, it can also serve as a basis for other scientific works – both in analogue and digital forms (Kraak, M-J. 2002; Kraak, M-J. and Ormeling, F. 2010). This emphasises the importance of proper maps in publications: if the map figure is inappropriate, it can be misinterpreted or not understood. The cycle of maps being interpretations and then base materials, then interpretations again, sometimes lead to scientific discoveries if the map was properly created in the first place; this was the case when Albert, G. *et al.* (2015) predicted the Pálvölgy Cave's volumetric size to be the largest in Hungary, based only on archive maps and polygonal survey data.

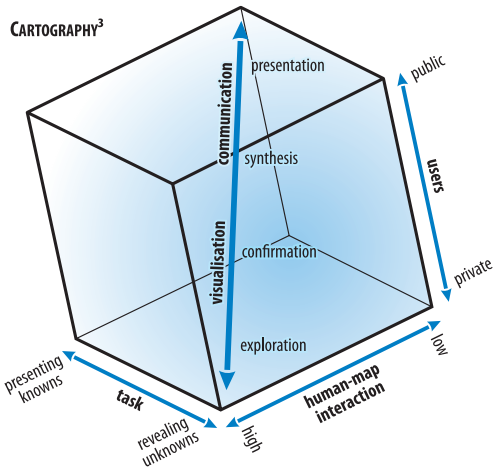

Fig. 1. The cartographic cube (MacEachren, A.M. 1994). Geoscientific thematic cartography is built on the steps presented in it.

DiBiase, D. *et al.* (1992, 1994) analyse the geovisualisation methods of earth sciences on the theoretical basis of the cartographic cube model, but data visualisation methods and interpretation have undergone many changes since that time. Due to today's data collection and recording methods, more and more spatial data are collected in geodatabases, which are too time-consuming to evaluate with traditional 2D methods, so instead of maps, the cognitive process often takes place in a virtual space (Albert, G. 2018). Even so, the final representation is still dominantly 2D (printed maps, figures, still images, etc.), and its purpose is to provide well interpretable scientific information for the reader.

Map figures must fit in the body of the publication and must enrich its content – or should be understandable alone without additional text (it is very useful when we just scan through articles for raising our interest). Map editing is usually an extra task for the authors and might be hard for non-cartographers to consider advanced visual and thematic cartographic rules, but certain features do not need cartographers' expertise and may improve the map significantly. With the correct use of them, map figures can be interpreted easier – gathering a broader audience.

Evaluating maps is not an easy task because there are many elements and aspects that can make a cartographic product a good spatial representation. However, there are some objective factors, such as map accessories (e.g. scale, legend, coordinates, name, and orientation), which help the reader, and their lack may cause misinterpretation. The quality of the topographic base, thematic coverage (raster/vector type), and printing (in the case of printed materials) are also objective factors, along with the presence of references for source materials. Altogether, these objective factors determine the reproducibility of the represented scientific results and give a clue to the reader how the research process took place in the first place. The preludes of this study examining the objective characteristics of geoscientific maps reach back to the 20th Carpathian-Balkan Geological Congress in 2014 (Tirana, Albania), where the

greatly varying quality of the presented studies' map figures triggered the idea of a systematic analysis of the problem. The core of the map evaluation system presented here was worked out during this conference by Gáspár Albert, and he also gathered some samples there. The main idea then was to determine the factors that make a map less interpretable.

This study examines the maps of different geoscience branches focusing on the map accessories and the quality rooting from cartographic standards. The classification of geoscientific maps declared by the ICA Commission on Thematic Cartography in the 1970s (led by Emil Meynen) distinguish seven categories (Klinghammer, I. and Papp-Váry, Á. 1983): 1) morphometric, 2) geophysical, 3) geological, 4) pedological, 5) geomorphological, 6) hydrological and 7) meteorological (climate) maps. Elements of this system refer to an individual science branch in geosciences.

To evaluate how the different disciplines manage maps, we have chosen journals and conference posters from the field of cartography, geography, geophysics, geology, and meteorology. The working idea was that we would find differences among the disciplines in the use of the objective factors determining the reproducibility of certain research. The spatial variability of map use was also supposed – there might be remarkable differences between each countries' map representations. This was observed in the prelude study as well: authors from countries where scientific publication has a longer tradition produced clearer maps. We especially focused on the differences between Hungarian and international scientific literature. Our main aim was to conclude the connections between thematic map use, scientific journals, scientometry, science fields, and geographical diversity.

Map sources: designated journals

To analyse the differences between the map use of geoscientific disciplines we have designated one Hungarian and one international English language journal dealing with geography, geology, meteorology, cartography, and geophysics. The reason for choosing Hungarian and English language international papers was to find the characteristics of thematic map use in Hungary too and make comparisons with the 'worldwide' data.

Only a few Hungarian earth science journals are in high quartiles or have high H indices, but we have selected the best one in each field based on scientometry (Hodge, D.R. and Lacasse, J.R. 2011). The international papers were chosen from high quartiles (Q1 or Q2). The source for scientometric data was the database of SCImago Journal & Country Rank (SCImago 2020).

The data gathering process from journals was the same for all five disciplines. We looked for the last available issue and started from there backward until reaching approximately 300 maps per field (~200 maps from international and ~100 maps from Hungarian articles). Besides these, we also took nearly 100 photographs of maps from posters at international conferences. They were also included in the evaluation.

We have tried to maintain a balance between each field in the number of representations to examine. Taking into consideration maps from journal articles and posters, we have evaluated a total of 1,509 maps. Data about the journals involved in this study can be found in *Table 1*.

The methodology of the evaluation

During the evaluation, each journal issue was searched for maps. The Cartographic Journal, Geodézia és Kartográfia and Földrajzi Közlemények were available in the library of the Institute of Cartography and Geoinformatics. The other papers were online: a print screen was taken from each examined map figure. Unique ID numbers were assigned to each representation to make further identification easier. The evaluation model is built up of six main groups, each of them defined by directives concerning the criteria (*Table 2*). The nationality of the first author was noted

Table 1. Scientometric data about the journals examined in this study based on the information from the database of SCImago Journal & Country Rank at the time of the study

Discipline	Journal	Country	H index*	Quartile**	Total cities in 2018
Cartography	*The Cartographic Journal* (from issue 2014-1 to 2018-3)	United Kingdom	25	Q2	132
	Geodézia és Kartográfia / Geodesy and Cartography (from issue 2014-1 to 2019-4)	Hungary	7	Q4	2
Geography	*Geoheritage* (from issue 2019-1 to 2019-3)	Germany	21	Q2	264
	*Földrajzi Közlemények**** / *Geographical Review* (from issue 2017-1 to 2019-2)	Hungary	–	–	–
Geophysics	*Earth & Planetary Science Letters* (from issue 2019-1 to 2019-4)	Netherlands	215	Q1	8,720
	Magyar Geofizika / Hungarian Geophysics (from issue 2010-1 to 2014-2)	Hungary	7	Q4	1
Geology	*Geology* (from issue 2019-6 to 2019-12)	United States	189	Q1	4,256
	Földtani Közlöny / Bulletin of the Hungarian Geological Society (from issue 2017-1 to 2019-4)	Hungary	9	Q3	21
Meteorology	*Quarterly Journal of the Royal Meteorological Society* (from issue 2019-7 to 2019-9)	United States	125	Q1	2,843
	Időjárás / Weather (from issue 2018-4 to 2019-4)	Hungary	13	Q3	59

*An entity has an H index value of y if the entity has y publications that have all been cited at least y times (Hodge, D.R. and Lacasse J.R. 2011). ** The set of journals have been ranked according to their SCImago Journal Ranking and divided into four equal groups, four quartiles. Q1 comprises the quarter of the journals with the highest values, Q2 the second highest values, Q3 the third highest values and Q4 the lowest values (SCImago 2020). *** Földrajzi Közlemények is not indexed currently in SCImago.

separately to provide data for visual criteria analysis by countries.

Map visualisation

There are three criteria in the 'Visualisation' group: excellent, medium, and poor. Although these categories seem to be subjective ones, the evaluation focuses on characteristics, which can be identified objectively. Good readability (due to properly sized and placed symbols and texts), unique and theme-fitting symbol set, the balance between the base map and the thematic content, and between the printing quality and the resolution of the map are the basis of the assessment within this group.

Layout types

The 'Type' group is evaluated by determining the purpose of the examined map in the article. It can place the study in question into a larger geographical content ('overview'), can show results in either small or large scale ('main') or can be a detailed map about the conclusions of the article ('detail'). However, there can be mixtures of these types that are

Table 2. Criteria of the map evaluation system

A) Visualisation – *Excellent:* The map is designed for its purpose. The symbols are unique or appropriately selected for the topic. The base map and the thematic content are in harmony. The printing quality matches the resolution of the map. – *Medium:* The content is readable, but the symbols are not designed for the purpose of the map (e.g. usage of default colours, line types). Base map and thematic coverages are compiled differently. The printing quality matches the resolution of the map. – *Poor:* The content is hardly readable due to inappropriate symbols (in vector-based maps), rough resolution (in raster-type maps) or the bad quality of printing.
B) Type – *Overview:* The map is for showing the location of the study area. It is a small-scale map, which can be solitary, or in pairs with the main map. – *Main:* The map shows the results of the research subject. It can be solitary or in pairs with a main- or a detail map. – *Detail:* The map shows the results of the research subject in a large scale. It is always in pairs with the main map. – *: in the case of mixed types, use the * sign for the inferred and '1' for the dominant type.
C) Accessorial (coordinates, orientation, scale, legend, name/title) – When doing the survey, put a checkmark in the proper column if the accessorial type exists on the map (consider the captions of figures as names/titles in some cases).
D) Topographic content (put a checkmark in the proper column if the accessorial type exists on the map) – *Hypsography:* contours, shaded relief, graded hypsometry, etc. – *Hydrography:* watercourses, lakes, rivers, channels, springs, wells, marshes. – *Road network:* roads, trails, streets, etc. (manmade structures). – *Boundaries:* delineator signs of administrational territories. – *Settlements:* signs of human build structures/administrational units (i.e. cities, villages, farms). – *Names:* geographical names (of natural and manmade objects).
E) Thematic content (in this criterion, all existing map types from the evaluated set should be written). In our case: – Geological, geophysical, geographical, geomorphological, meteorological, cartographical, ethnographical or general, if there is no thematic content.
F) Base map type – *Copy unreferenced:* scanned raster from an existing map without citation. – *Copy referenced:* scanned raster from an existing map with citation. – *Edited:* edited topography/thematic base map content with references to the source of data. – *Vector:* the base map seems to be edited, but the data source is not indicated. – *No data:* the base map exists, but there is no information about it. – *No base map.*
G) The nationality of the article's first author

marked with the help of an asterisk (inferred type) and a '1' (dominant type). In the latter case, the maps counted as their dominant type.

Map accessorial

The presence of certain elements makes a compiled figure a map. The role of map accessorial is to give information about the geographic position and extent of the presented territory, the meaning of the thematic symbols, and others. Some of them are necessary, and some of them are optional. The necessary ones are the coordinates, orientation (usually the direction of North is marked – but sometimes the letters before the coordinates substitute this), and name (this can be substituted by the figure caption). Optional accessories are the legend (it can be omitted, for

instance, on overview maps), the graphic or numeric scale (coordinates may serve as scale bar), and the colophon (not present if such information is mentioned elsewhere, e.g. in the article/book that contains the map). Each accessorial, except for the colophon, was checked during the evaluation; either it was on the map layout or in the caption.

Topographic content

Some topographic content is essential in all thematic maps: by looking over the plotted physical characteristics of the examined area the reader can imagine the displayed topic in a geographical context. The topographic content comprises features such as hypsography, hydrography, road network, boundaries, settlements, and geographic names. However, there exist geoscientific maps that do not require the presence of some of these features – either because of thematic data density (e.g. hypsography is often omitted from geological maps), irrelevance (e.g. detailed hypsography is irrelevant on some geophysical maps), or small scale (e.g. meteorological maps). The topographic content is part of the background map unless one or more of its features are clear subjects of the article's topic (e.g. in case of research on relief, hydrology, traffic, etc.). We recorded the presence of the topographic features on the examined maps, which made it possible to get the different thematic map types under a unique evaluation.

Type and source of data content

The next evaluation criterion is the determination of the genre of the thematic content (e.g. the map is geological, meteorological, ethnographical, general, or any other). This category usually came automatically due to the journal where the map figure was published. The categories refer to the type of base data that was processed in the compilation of the thematic content.

The last group examines the source of the base map and the copyright situation of the base map content. Referenced or unreferenced copies and edited or self-made base maps are also common. Though the base map usually contains topography, in some cases published thematic maps were used as base maps for the representations (e.g. tectonic lines placed on a published geological map). Most journals recommend submitting vector images and high-resolution raster maps that can be modified by the editor without significant loss in printing quality (note that printing quality was an evaluation criterion in the first group). However, it is very common to combine the two types in the course of editing the figure map, with the result being a raster-type figure. Ideally, the thematic content is edited by the author(s) on a properly cited good quality base map.

The structure of the database

The evaluation process was carried out with MS Excel software. Two individual tables were opened for each geoscience field and two for the posters. One contains information about each article (name of the journal, title, authors, date of issue), while the other table contains the evaluation records. The tables are connected by the unique ID of every article. As most of the evaluation criteria deal with the presence or lack of certain map features, we used a '1' mark to indicate if a certain feature is on the image and left the database cell empty if not. The statistics were separated into a new spreadsheet and organised for the desired purpose: to make comparisons between branches of science and based on the nationalities of the first authors.

Evaluation of map compilation habits in earth science disciplines

After summing up the scores in the worksheets, each criterion group was evaluated with basic statistics and visualised using bar

charts. For the evaluation, we also used the built-in functions of Excel.

The quality of map visualisation was sorted into one of the following three categories *(Table 2*, A*)*: excellent, medium, and poor. The general percentages concerning each field are the following: 62 percent of the cartographic, 80 percent of the geographical, 69 percent of the geophysical, 86 percent of the geological and 77 percent of the meteorological maps are excellent, 14–35 percent have medium quality while the proportion of poor maps is around or under 3 percent in all five cases *(Figure 2)*. Larger differences between the disciplines exist in the medium and excellent categories.

The order of science branches according to the largest quantity of visually excellent maps may seem surprising. The largest number of 'excellent' maps (258) comes from the geological thematic category. It is followed by geographical (250), meteorological (230), and geophysical (210) maps. The least number of 'excellent' maps (181) occur in the cartographic dataset. The data are visualised in *Figure 2*.

The map visualisation in the various disciplines shows remarkable differences if we summarise the scores for the Hungarian and the international English language journals *(Figure 3)*. In most cases (geography, geophysics, geology, and meteorology) international papers have a higher proportion of "excellent" maps (the largest contrast is between the quality of geophysical representations). The percentage of "poor" quality maps is low in both cases regarding every discipline. Surprisingly, the trend is reversed when examining maps of cartographic journals: more maps in the Hungarian papers are evaluated "excellent" than that of international issues.

The used map types – overview, main, and detail – also varies by disciplines *(Figure 4)*. Geography, geophysics, and geology use mainly overview maps (66%, 63% and 82%, respectively) to present different characteristics of the sample area, while cartography and meteorology use this type less frequently (25% and 41%). The tendency is reversed in the case of main maps: maps in cartographic journals and meteorological maps use this type more often (68% and 59%) and the other disciplines rarely (17–37%). The presence of large-scale detail maps is not significant – the results are usually presented in main maps or inferred detail maps.

The results concerning map accessorial is also diverse *(Figure 5)*. Nearly all maps have a name/title (97–100%), which partly comes from the evaluating method: figure captions were recognised as titles. The presence of legend is more diverse (52–83%), but the cartography discipline differs significantly from the other science branches.

The cases of the other three elements are also diverse. The use of "scale" on maps is equally high (73%) for the geography and geology disciplines and low for the geophys-

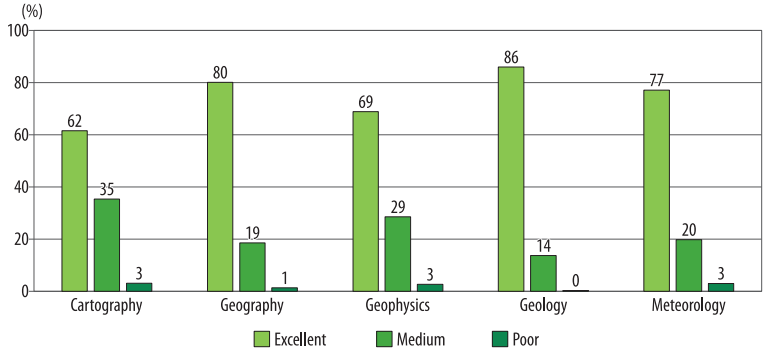

Fig. 2. Results of map visualisation criteria category. Most maps fall into the 'excellent' category, but the range of the difference is significant (24%) between the disciplines.

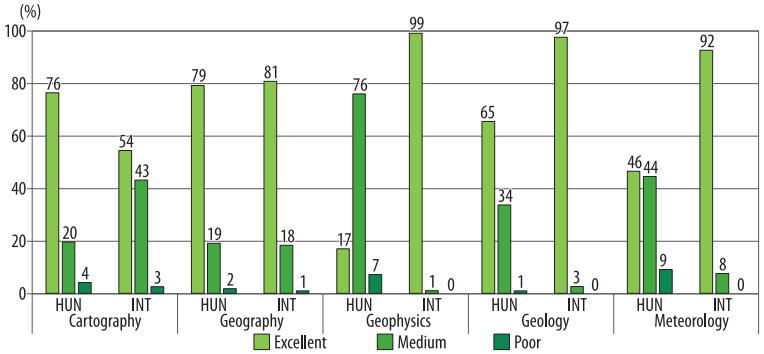

Fig. 3. Map visualisation criteria results per disciplines in case of Hungarian and international journals

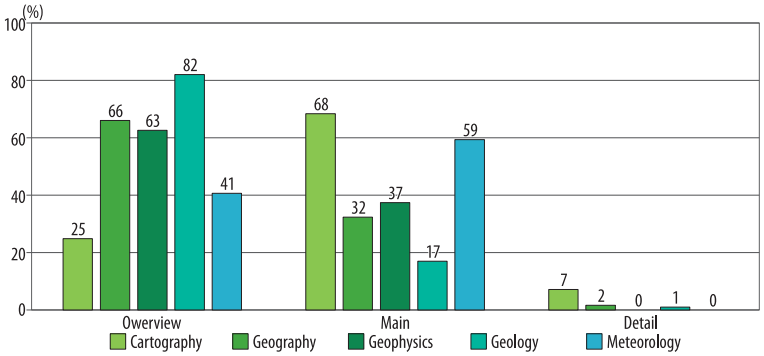

Fig. 4. Map types mainly used in geoscientific maps. Geography, geophysics, and geology mainly use overview maps, while main maps are rather common in cartographical and meteorological articles.

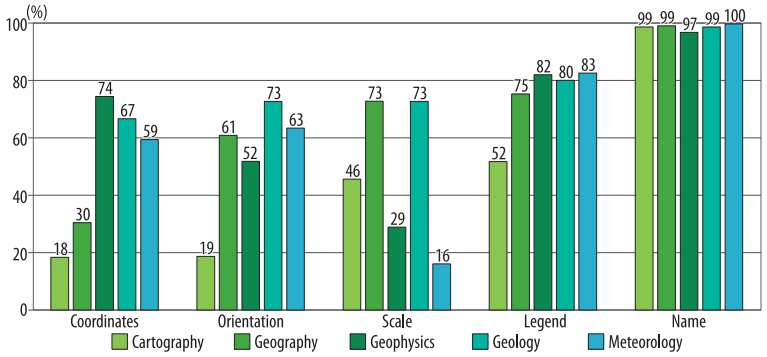

Fig. 5. Results of the accessorial category. The evaluation based on the presence of map elements have a more diverse outcome: coordinates, orientation and scale are often omitted from geoscientific thematic maps.

ics and meteorology (29% and 16%, respectively). Cartography is in between the two groups with 46 percent.

In the case of "orientation", the pattern is similar to the situation of "legend": the maps in cartographic journals do not usually show it (19%), while all the other disciplines do (52–73%). The use of coordinates on map figures can be divided into two discipline groups: those who rather display this information (geophysics, geology, and meteorology with 74%, 67% and 59%), and those who rather do not (cartography and geography with 18% and 30%).

The presence of topographic elements is evaluated by map feature categories. Hypsography is the least used on meteorological maps (7%) but is almost equally present on maps of the other disciplines with 23–33 percent. Nearly the same tendency (but with 11% on meteorological, 34% on geophysical and 52–57% on the other maps) is true for hydrography. Road network is the least common topographic element in geoscientific thematic maps: only 1–5 percent of geophysical, geological, and meteorological maps use this map data type. It is underrepresented even on geographical maps (21%) and on maps in cartographic journals (34%). Boundaries as the shapes of countries are mainly drawn in the maps to help the reader to place the shown area in a geographical context. Their proportion is relatively low in geological maps (27%), medium (48–52%) among cartographical, geographical, and geophysical maps, and high (77%) in the case of meteorological maps. Settlements are rarely shown on meteorological (6%) and geophysical (14%) maps, but three out of four geological maps also lack this map data type. The remaining disciplines show settlements between 43 and 52 percent (cartography and geography). Geographical names are the most common topographic elements in geoscientific thematic maps: 87 percent of geological, 73 percent of geographical, 59 percent of cartographical and geophysical representations contain such elements, and only the meteorological maps do not usually show them (13%). These data are visualised in *Figure 6*.

The base map type evaluation is the most diverse group: the deviation between the discipline percentage values is the highest in this evaluation category. Most maps are well-referenced (e.g. cartography – 46%) or without base (e.g. cartography – 49% and meteorology – 57%). Unreferenced scanned maps are not frequently used (0–15%), but it is relatively common not to provide any information about the base map, as, for example, in the examined geographical (41%), geological (41%) and meteorological (21%) articles. Well-referenced unmodified scanned raster maps as base maps are most common in cartography (46%), while the other disciplines tend not to use such base maps (5–18%).

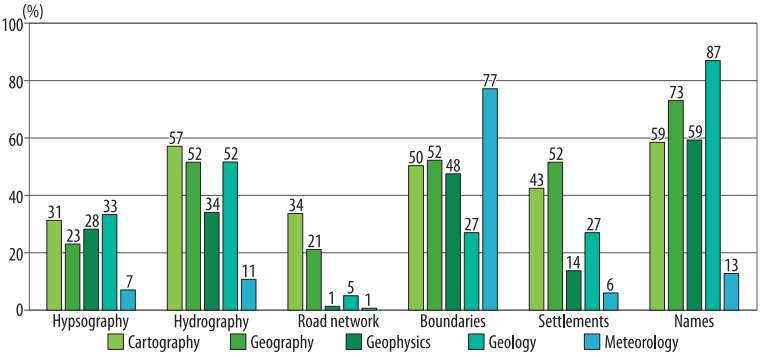

Fig. 6. The presence of topographic elements in geoscientific thematic maps. This is a rather unbalanced evaluation category. Road network is usually omitted from maps, while geographical names are common.

The use of edited (modified) base maps with references is frequent in the geophysical and geological papers (45% and 46%), less common in the geographical and meteorological papers (24% and 14%) and rare in cartographic papers (5%). Edited (modified/digitised) maps lacking the data source are not representative in the dataset except for the 1 percent in geophysics. The base map information is summed in *Figure 7*.

Analysis of the visual criteria by countries

The examined maps can be divided into two groups: maps from the Hungarian and the international papers. Approximately one-third of the maps per geoscience field came from a Hungarian journal (these are maps mainly with Hungarian first authors), while the remaining two-thirds came from international journals with mainly foreign first authors. Based on the affiliation of the first authors, the total number of countries was 48, where the number of recorded maps was 31.65 per country by average. We have analysed the visual criteria group to compare Hungarian means with international trends. Countries with more than 20 records can be seen in *Figure 8*.

Thirteen countries were selected for further analysis; these are mainly from Europe (8 countries), the United States, China, Australia and Brazil. In *Figure 9*, the 13 countries with more than 20 evaluated maps are compared to each other; also, these countries are the ones that set up the "International (developed)" category in *Figure 9*. The maps with first authors from Spain, Norway and the UK have the best proportion of visually "excellent" maps (greater than 90%), while the USA, Germany, France, Poland, and Brazil have just a bit more "medium-" and/or "poor-visualised" maps (less than 20% altogether). The situation of Chinese, Swiss, Australian and Italian maps is different: 69–77 percent of the evaluated maps are "excellent", 21–31 percent are "medium", and usually there is a little group (0–3%) of "poor-quality" maps.

Comparing the maps in the papers with Hungarian and foreign first authors *(Figure 9)*, the differences in the visual evaluation are remarkable: 85 percent of the maps in the international set are "excellent", while the rate of the same category in the Hungarian set is only 58 percent. The proportion of "medium-quality" maps is 14 percent internationally and 39 percent regarding Hungarian first-author articles. The number of "poor-quality" maps is nearly the same (3–1%) in both sets.

Upon the evaluation of the remaining countries from the international dataset, a

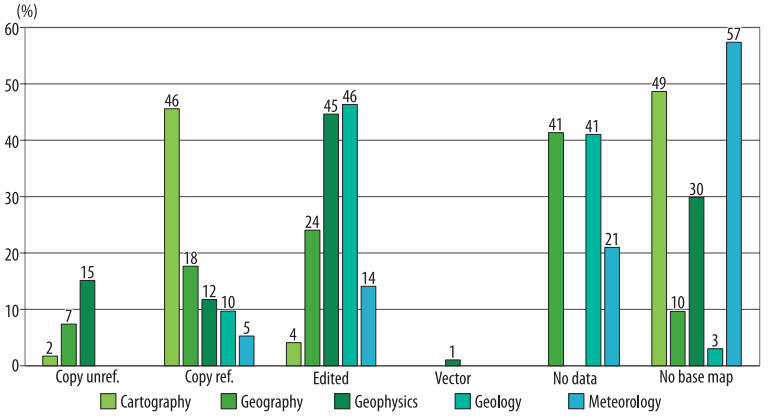

Fig. 7. Base map data of the examined maps by disciplines

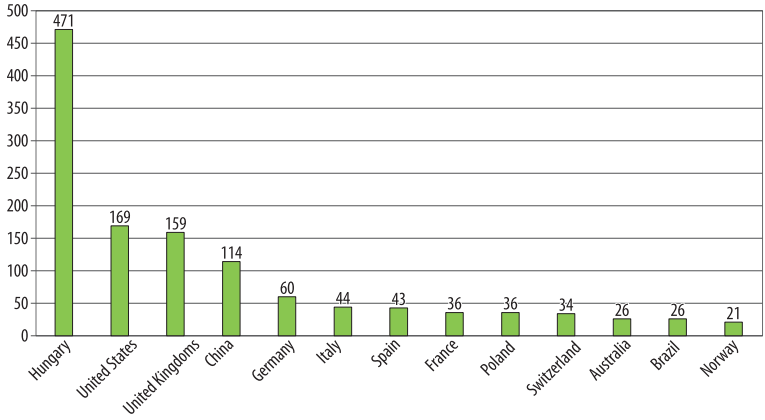

Fig. 8. The most common countries with the first authorship having more than 20 records in the examined maps database. The total no. of countries was 48 where the number of records was 31.65 on average.

group was distinguished that includes the developing countries of Africa, Asia, South America, some of the countries from the Balkan Peninsula, and the former communist countries of Central Europe. This group is referred to as the "developing areas" in this study and shows similar percentages in the visual evaluation as the Hungarian dataset. There are 773 maps (~50% of all) in the examined database from "developing areas", where the average visual score was considerably poorer (63% excellent, 34% medium, 3% poor), despite the maps having appeared in international journals.

Discussion

Each thematic map has different purposes, and the results confirm this. The criteria "Visualisation", "Type" and "Base map type" (see *Table 2*) can be assessed by universal means, but all other criteria depend not only on the author but also on the data that he or she wishes to transmit. This means that the attributes "Accessorial", "Topographic content", "Thematic content" and "Nationality" provide first and foremost an insight into the current state of map use in the earth sciences in the form of statistical data.

The relationship between the quality of journals and maps can be determined. Journals with higher H indices and higher quartiles have stricter editorial rules: images and maps of medium and poor quality are thoroughly filtered by the editorial board. These papers often require vector images that can be easily modified or resized during the editorial process. The difference in the visualisation scores can also be explained by this: disciplines with prestigious and long-standing journals having high scientometric scores produce more "excellent" maps.

Map quality is also connected with usability and legibility, not only with formal cartographic rules. The most important purpose of representations is to provide meaningful scientific information. Consequently, there are some factors that can be examined from the user's point of view. Feedback from map readers can contribute to map development by identifying and indicating features that make understanding difficult. As a result, further visualisation methods and editing aspects may emerge as new perspectives. Albert, G. *et al.* (2017), and Szigeti, Cs. *et al.* (2018) address, for instance, the interpretability of maps and the issues and editing solutions regarding map symbology. Such an examination can also be carried out on geoscientific maps.

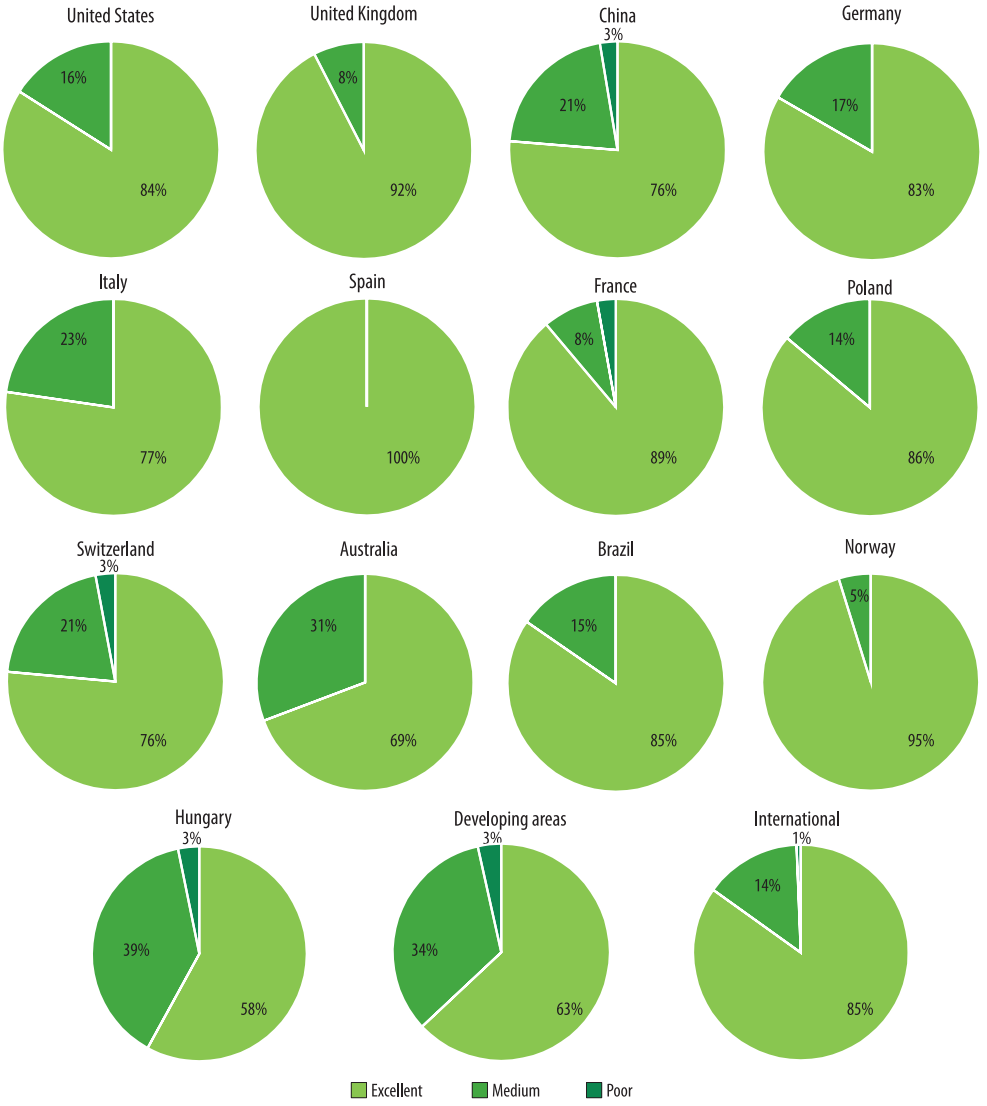

Fig. 9. Visual evaluation of maps from countries having more than 20 maps

Although map editing has become a routine task in the geoscientific community with the emergence of various GIS tools, knowledge of cartographic rules does not come with the software, and it is a difficult task to design visually satisfying and informative maps that conform to these rules. The presence of map accessorial (*Figure 5*: coordinates, orientation, scale, legend and name) was expected to be a good indicator for the author's experience in map making, but as their use was the least frequent in the cartography discipline, it is more likely to depend on the standards set by the journal or its editors. However, only the journal: "Geology" has guidelines regarding coordinates, scale, and orientation among the

examined journals. This means that in most cases, the maps were probably enhanced by a thorough editorial process in which the inappropriate maps were filtered out and revised.

The topographic content (*Figure 6*) of a geoscientific map is mainly the part of the base map – and has a role in locating our thematic map in a geographic context. The hypsography, hydrography, road network, boundaries, settlements and geographic names are there to help the reader, and the various disciplines require some of these to be omitted. The base map (usually from a different source) that contains topographic information must be referenced. Higher editorial standards demand self-edited vector maps because these can be resized and edited easily during the editorial process. Raster base map layers are not suitable for modification because of the large quality degradation. Unclear copyright issues are not usual in high-ranking journals, but we can face some unclear issues, as this study also shows.

The main map types are closely related to the geoscientific branches (*Figure 4*). Some fields have a fundamental need for cartographic representation of their data (they mainly work with spatial information – such as cartography, geography, and meteorology). They use main maps to present results on a larger scale. But there might be topics that are not closely linked to spatial factors: e.g. geochemistry or atmospheric physics. These disciplines rarely use main or detail maps, just overview maps in some cases to depict the sample area.

We have examined the visual characteristics of the maps by countries of the first authors. The other criteria groups were not analysed in this way because a larger number of evaluated maps per discipline would be needed to examine country- and science branch-dependent factors at the same time. Correlations can be drawn between good visual quality and countries with a long history of modern scientific publishing. Thus, the UK and the USA have much better visual scores than China or Hungary, for instance. Many articles and maps come from developing countries, where the tradition of scientific publication is weak *(Figure 8)*.

Although we tried to reach an objective result, the proposed methodology may have some shortcomings or flaws. Its thematic map groups are based on the official ICA categorisation (Klinghammer, I. and Pápay, Á. 1983), covering a very broad range of disciplines. This may result in distortions, as the use of maps in some scientific fields is not restricted to a narrow set of map features but uses a great variety of them (e.g., road networks are not necessary in a population density map but are useful when presenting transportation data – but both are geographical). The personal opinion of the evaluators can cause a potential bias: the aesthetic parameters and features influence the evaluation in a subjective way. This is controlled and, to a certain extent, kept in check by the numerical form of evaluation.

As 3D graphics are traditionally considered as map-like representations rather than maps, this methodological framework is not completely suitable for evaluating them due to the formal cartographic rules. A modified version of the model can be developed later to examine these representations.

Conclusions

In this study, we presented an evaluation system (see *Table 2*) that is available to assess any thematic map published in scientific journals. By using this objective method, visual qualities, map types, map accessorial, topographic elements, thematic content, base map types and unique geographical characteristics can be determined. We have conducted a case study involving 1,509 maps, ~300 per each field of geoscience (cartography, geography, geophysics, geology, and meteorology), from one Hungarian and one international English language journal per discipline. The selected maps were analysed according to the criteria groups of the presented model. The following conclusions can be drawn from the thematic maps for earth sciences:

We conclude that in the cases when the quality of maps is poor or medium, and es-

sential map elements are omitted, the reason was partly due to the less strict editorial rules (e.g. Hungarian geoscientific journals) and the lack of modern scientific publishing tradition.

The analysis of the visual criteria, the type and the base map can be evaluated universally for all disciplines and serves as an important basis for comparison.

A new style of map use can be determined by thoroughly evaluating the scientific maps of the past years. This is specific to each discipline and can be characterised by the statistical analysis of map accessorial and topographic elements.

The presented method is suitable for the assessment of any kind of scientific thematic map, not only for the earth science disciplines discussed. Since certain directives on the preparation of figures and captions for maps are very rarely found on publishers' websites, the criteria presented here can also be used as a checklist for the preliminary evaluation of maps prior to publishing, as well as for journal editors and reviewers when working with submitted manuscripts.

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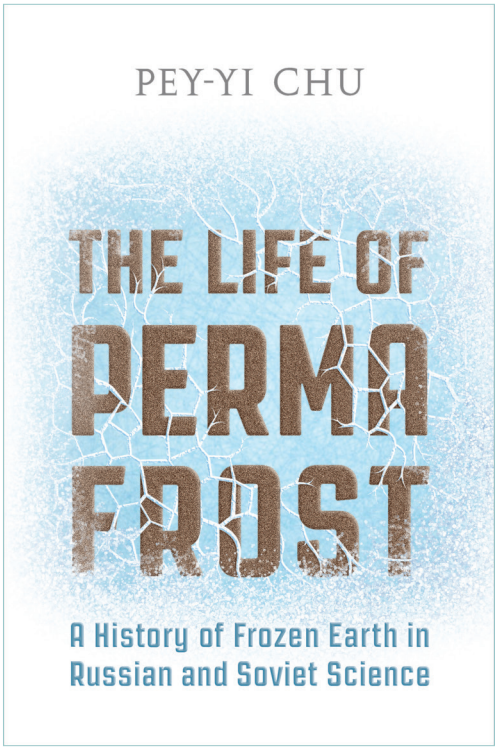
BOOK REVIEW SECTION

Chu, P-Y.: The Life of Permafrost: A History of Frozen Earth in Russian and Soviet Science. Toronto–Buffalo–London, University of Toronto Press, 2020. 288 p.

In the era of Anthropocene, it is important to synthesise and uncover the relationship between humans and nature throughout the past centuries. The timing could not be better to resurrect the history of the recently unstable permafrost zone at the timeliness of global climate change. Investigating the changing permafrost is considered a hot topic in light of the positive feedback loop it may cause in the climate system. In the 21st century, permafrost is recognised as a 'time bomb' in relation to the climate change. Due to the rapid temperature rise this mostly high-latitude area of the world is thawing. During this process, microorganisms decompose the detritus of plants and animals which had been frozen underground. As a result, carbon dioxide and methane are released, increasing the amount of greenhouse gases in the atmosphere, which intensifies warming (Schuur, E. *et al.* 2015). The question may arise how something can change and be so unstable if its name implies it is permanent. Such terminological problems are rooted in the epistemological and ontological dialectic permeating the history of research on frozen earth. The complex processes during the life cycle of permafrost embrace many phenomena inseparable from each other, including nature itself and culture, society and political ideology. Therefore, science must be put in its place, by exploring the local and national context of knowledge production.



The volume addresses questions around the various conceptualisations of frozen earth throughout the 19th and 20th centuries. It recovers the multiple ontologies of permafrost, mainly in terms of whether it is a structure, a space, or a condition. Related questions include how the discourse has evolved and what kind of social and political phenomena and which scientific disciplines have contributed to shaping it. Finally, the author discusses what we can gain by recognising the multiple aspects of permafrost.

The book contains five main chapters, each divided into four subsections and a conclusion. Chu reveals the birth of frozen earth as an object of scientific research, the challenges of applied study, encapsulated debates, the adaptation of scholars to environmental and political conditions, and, lastly, the broad adoption of related terminologies. The chapters focus on how the term of frozen earth has been academised by extending it with adjectives and word collocations, which have changed over time according to the different motivations of scientists studying permafrost. The author uses a metaphor to bring this process closer to the reader, describing the life cycle of permafrost by comparing it to a butterfly.

In the introduction, the author explains her aims and puts the subject in its spatial and temporal context. Most importantly, she declares her goal is neither to cast doubt on the legitimacy of permafrost as a scientific term, nor to decide which concept of permafrost is more valid, but to historise the notion of permafrost, the altering scientific context of which she presents in the following chapters.

The first chapter (*Mapping*) is dealing with the embryonic phase of the concept of permafrost in 19th-century Russian Empire, when the first expeditions took place to Siberia. According to that, scholars were aimed at providing a synthetised conceptualisation of frozen earth and its relationship to climate, physical geography, and the history of Earth. The frozen condition of the land became a research subject

on its own right, with a specific geographical distribution, covered by a growing network of observation stations. This approach fit Siberia into the Empire-wide and global perspective. These efforts also were in line with a Humboldtian approach to science. Yet, there was disagreement about what is actually being investigated: earth, ice, space, condition, or all aspects as a whole? The first scientific names were born in the Russian Empire, but in German language: *Boden-Eis* or 'soil ice,' referring to a substance, and *Eis-Boden* or 'ice soil,' referring to a space. In fact, a dialectic was created between the application of the concept as a component of earth system, and understanding it as an aggregate physical structure, a substance.

In chapter two (*Building*), frozen earth emerges as an object of engineering related to a physical-geographical structure, the ground. The leaders of the Russian Empire decided to improve infrastructure to encourage the development in eastern Siberia. Therefore, they undertook construction works at a very large scale, often without proper scientific knowledge and methodology. Russian engineers were the first to confront with permafrost conditions like swamps, bogs, peatlands and icings, damaging and deforming already set up infrastructures. The chapter presents that imperial engineers explicitly urged for an applied research on frozen earth, the soil science of roads. This practice continued after the Bolshevik Revolution along the 1167-kilometre Amur-Yakutia highway. During this stage, an epistemology oriented to the needs of engineering strengthened only the one side of the dialectic of permafrost.

Chapters three and four (*Defining* and *Adapting*) concentrate on what one may call the 'pupal' stage of the historical life of permafrost. At this phase, a scientific name and definition was formulated in the Soviet Union by the scientist Mikhail Sumgin. Eventually, his adaptation *vechnaia merzlota* gave rise to the English word *permafrost.* However, the definition generated controversies. Chapter three focuses on the debate between Sumgin, who regarded the phenomenon as permanent from the (anthropocentric) point of view of human life, and his rival, a gifted geographer, Sergei Parkhomenko, who considered *merzlota* a process formed in geologically recent times, taking thus a geocentric approach.

Chapter four reveals the process by which the definition started to spread. Pakhomenko's goal was to establish the correct fundamentals for understanding frozen earth, while Sumgin concentrated on producing knowledge that contributed to the development of the Soviet economy in a relatively short time. According to the needs of civil engineering, Sumgin's approach gained priority, which also embodied in the first full-fledged institute for frozen earth research. In those years, the centralisation of science in the USSR left no room for multiple conceptions of frozen earth. Sumgin's interpretation of frozen earth was in line with the major objectives of the Soviet state, which conceptually separated humans from nature, thereby implying the former being capable of conquering the latter, dramatically transforming landscapes to suite them to needs of the national economy and to get access to its treasures. In this approach, the environment was defined as both an enemy and a mystery. This chapter guides the reader to the conclusion that Soviets did not conquer the nature, just adapted to the conditions it provided, which was an economically better move than to eliminate the perennial frozen ground. The author also argues that Soviet scientists, by focusing on industrial development, contributed to the generation of waste and pollution that endangered human and non-human lives, which cannot be ignored.

Chapter five (*Translating*) puts the reader in front of the adult stage of the notion of permafrost in the post-WWII Cold War period, when the concept started to spread internationally, although the framework and the subject of this new scientific field lacked a clear definition. After Sumgin's death, the post-Stalinist ideological revival provided space for younger scientists in the Soviet Union (especially Grigoriev, Redozubov and Shvetsov) to revive the alternative understandings of frozen earth. They promoted the concept of frozen earth as a space, the *cryolithozone*. They also involved the heat exchange as the key of the process, while employing some principles of Marxism-Leninism, which resulted in a concept of universal consistency rather than an ad hoc and oversimplified concept. Yet, the general circumstances did not allow the new generation's ideas to become dominant, neither in the USSR, nor abroad. By then, Sumgin's views had already taken roots internationally, mainly in the United States, due to which permafrost became the scope of a programme by the Military Geology Unit. Although translations by Russian speaking earth scientists tried to highlight problems in terminology, the Sumginian term corresponded well to the army's practical needs, as its simplicity facilitated quick communication, similarly to the case of Russian-Soviet infrastructure development programmes.

According to my subjective evaluation, *The Life of Permafrost* is a significant contribution not only to environment history but to history of science and to geography as well. It successfully responds to social, ideological, environmental, and linguistic challenges of the topic widely known as permafrost. Human interactions with the environment mainly take the form of adaptation of the former to conditions of the latter. Poorly prepared, forced construction megaprojects and agriculture-related activities had already caused, or will cause, problems that we are not yet aware of. The book focuses on the Russian Empire and the Soviet Union, but with the rise of Soviet influence, the whole communist Eastern Europe was caught up

in the sovietisation of science and policy, including forced industrialisation, the cultivation of new crops like cotton and lemon, and related water management projects (Turnock, D. 1996; Pavlínek, P. and Pickles, J. 2004). The landscape changes caused by mining (Lintz, G. *et al*. 2007), the altered hydrological and ecological conditions resulting from the installation of hydroelectric power stations (Balon, E.K. and Holčík, J. 1999; ; Trásy, B. *et al.* 2018) and the provision of irrigation to meet the needs of agriculture (Ujházy, N. and Biró, M. 2018) have led to irreversible environmental changes. The damming or diversion of rivers has extensively disturbed ecosystems as well as the interaction between surface water and groundwater (Trásy, B. *et al*. 2018). The installation of nuclear power plants may raise security issues due to insufficient knowledge on, and sometimes unjustified underestimation of, Quaternary tectonism, e.g. the potential reactivation of pre-existing shear zones, and seismicity (Tóth, T. and Horváth, F. 1997; Bada, G. *et al.* 2007). Thus, there is a risk that excessive environmental transformation and exploitation may backfire later.

In conclusion, I found this book very informative. The quality is greatly enhanced by the author's style, which makes the book easy to read. It is illustrated by maps and diagrams from former researchers which well support the arguments of the author. The research behind the study was built on a forceful combination of scholarly literature, archival sources and powerful storytelling that brought permafrost to life, while also employing most recent scientific findings on global climate change. Oversimplifications like 'melting permafrost' may cause false imaginaries of the climate change, which affects education and political decisions as well. In line with these, the author's comments on the current use of the term *permafrost* are entirely valid. The framework of Anthropocene evokes humans as a geological force that leaves an imprint not only on the Earth's atmosphere, but also on its soils, water bodies, and living nature (Steffen, W. *et al.* 2007), manifested as antropogeomorphology (Granados Aguilar, R. *et al.* 2020). That is in harmony with the author's final thoughts, that the elements of the environment may be studied, learned from, lived with, and perhaps mourned, but neither saved nor conquered. I do believe this volume will encourage further research on environmental history and history of science in other regions of the world that are underrepresented in mainstream global scholarly literature.

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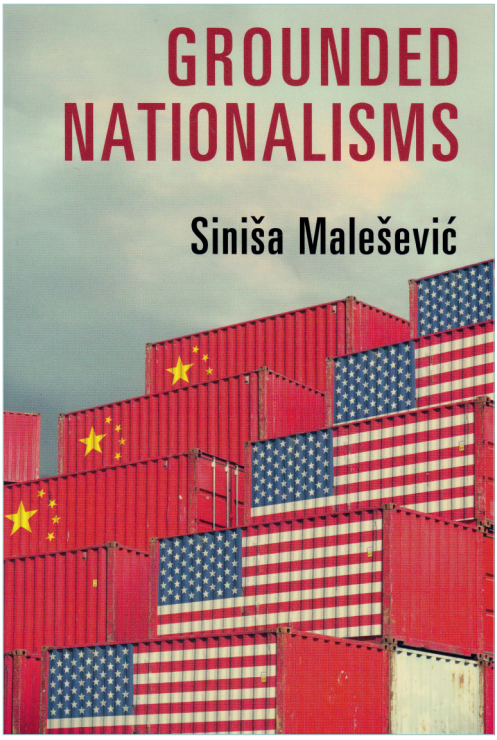
Malešević, S.: Grounded Nationalisms: A Sociological Analysis. Cambridge, Cambridge University Press, 2019. 312 p

The discussion over nationalism has come of age but has not run its full course yet. Despite the vast volume of former and contemporary literature on nationalism, the narrative discourse around it continues to this day. While recent studies reveal new faces of the idea and the social movement, old debates re-emerge again. Among these discussions, *Grounded Nationalisms* seems to be a milestone. It is a grandiose concept that seeks to give nationalism studies a unique, comprehensive theoretical framework, while offering an opportunity to integrate former, often contradictory theories. The author's fundamental approach to the contemporary role of nationalism is denying the idea that the age of nationalisms is slowly coming to an end under the pressure of the postmodern, globalised world. On the contrary, he argues that this phenomenon is getting stronger even if it is subsided or not always dramatic. In a nutshell, Malešević tries to explain that although nationalism stems from the modern era, it has roots in the Middle Ages. Furthermore, it has been constantly ubiquitous and adapts perfectly to the incessantly altering social-political circumstances, so those who predict its decline are greatly mistaken. The theoretical framework which supports his argumentation is based on the author's previous works and provides a solid basis for his interpretation. Although Malešević is not a geographer, national narratives have substantial territorial aspects, and geopolitics, area studies and the geography of belongings are also closely linked to the discourse of nationalism.



Siniša Malešević is an Irish researcher originally from Banja Luka (Bosnia and Herzegovina). He lives in Ireland and is a full professor of sociology at the University College Dublin. His previous work on the subject may also have contributed to the fact that *Grounded Nationalisms* has been awarded a runner-up (honourable mention) in the 2020 Stein Rokkan Award for Comparative Social Science Research. Malešević's 312-page book consists of 11 chapters apart from the *Introduction* and *Conclusion*. Each chapter also stands as an independent reading, as some of the author's previous works appear here in a revised form.

'Grounded nationalisms' is the answer to the questions of why nationalism is so enduring in the modern era, why it is present at all levels of society, and why it is able to constantly innovate. The author's compact explanation is that because nationalism is historically, organisationally and ideologically grounded as well as micro-interactionally. 'Historically' means that where it appears, it will be strengthened and become dominant at all levels of society. However, this was not a quick process, but it took a long time for becoming a prevailing operational ideology throughout history. Achieving national unity, as it happened in the 19th and 20th centuries throughout the world, required strong organisational power. This was often exercised through coercive measures, so national movements became 'organisationally grounded' and have remained like that to this day. All of this could have come hard without a strong and popular ideological foundation, such as 'collective liberation' and 'emancipation,' as it proclaimed equality for all who belonged to the nation. Furthermore, the modern nation-state also lives in a continuous process of ideologisation and gives a national interpretation to a vast majority of social realities, therefore, 'ideologically grounded.' Lastly, nationalism also plays a powerful role in everyday practices, as nationhood is discursively constructed through daily routines, so it is 'micro-interactionally grounded.' The above mentioned four notions of nationalism constitute the conceptual foundation of Malešević's complex theory.

The main aim of the book is to show that "successful nationalist projects are premised on the organisational translation of ideological grand narratives into

the micro, family and friendship-based, stories" (p. 14), in addition to "how grounded nationalisms develop, operate and expand" (p. 15). Furthermore, Malešević focuses on "the organisational, ideological, and micro-interactive underpinnings of nationalisms" (p. 15).

Although the author and the publisher have not divided the book into larger parts, three major sections can be revealed. In the first part (the first three chapters), Malešević discusses his own theory in detail and compares it with other approaches, explanations and interpretations of nationalism. The second part (Chapters 4–5, and also Chapters 10–11) discusses some significant theoretical issues illustrated by particular examples from the Balkans, but also from other areas in Europe and beyond. In the third part (Chapters 6–9), he explores the regions or countries that have been scrutinised by him in his previous works as well, such as Ireland, Serbia, Bulgaria, presenting these national contexts within the theoretical framework outlined earlier.

The first chapter provides a detailed description and explanation of the author's complex theory. Firstly, he examines nationalism as an ideology. Regarding the widely accepted theory that nationalism is fundamentally a product of modernism, the author, although not denying it completely, takes the view that nationalist ideologies are deeply rooted in the past, which contributed greatly to the success of ideological penetration. In this respect, he contradicts Gellner's 'Big Ditch' thesis and Polanyi's 'Great Transformation' hypothesis (Hann, C. 2015), which clearly contrast modernism with the ages that preceded it. Malešević, on the other hand, also describes a significant difference between the modern and the Middle Ages. He points out that the legitimacy of power had divine origin in the past, whereas it is granted by popular sovereignty in modern nation-states. Amplifying the conceptual basis, he does not elude thorny questions, such as the priority of the nation or the state. In this 'the chicken or the egg causality dilemma' of whether the nation-state was first or the nation, he clearly takes the position that the state created the nation. Thus, those empires, kingdoms, and principalities were transformed into a nation-state where a national community could emerge. The further chapters of the book also show in detail that even without gradual transition, for instance, where transformations were initiated by wars or revolutions, the process led to the formation of the nation-state likewise. In fact, he argues that the social organisations and structures are a prerequisite for establishing the nation-state. All of this, however, required a strong and pervasive ideology that permeated all levels of society, a process Malešević calls 'centrifugal ideologization'.

Turning to social structures and national identity, Malešević indicates that, especially in the 19th and 20th centuries, national structures were often strengthened between violent and bloody events. He calls this 'coercive organisational power,' but he means not only physical violence, but also structural. According to the author, nation-states, through their strong legitimacy and enormous organisational and coercive capacity, are able to interpret social reality in a special way, creating the image of 'national identity'. Malešević considers this to be valid to this day, as most social organisations are overseen or run by the nation-state. Furthermore, it can be underpinned by the experience that people's lifecycle is supported and dependent on the nation-state from birth to death. This nation-centric worldview would not be maintained without everyday practices which notion was elaborated first in Michael Billig's *Banal Nationalism* (Billig, M. 1995). Billig is highly cited in *Grounded Nationalisms*, but Malešević goes beyond Billig's notion and argues that the phenomenon he calls 'micro-solidarity,' which constructs national identity through everyday face-to-face relationships, needs to have strong organisational background as well.

In the second chapter, the author tries to reconcile the theories implying, on the one hand, that nationalism can be traced back to the Middle Ages or even earlier historical times, and on the other, that it is a completely new phenomenon. Malešević explains with the help of the concept of *longue durée*, which deems nationalism as a long-term creative process, and argues that the two aforementioned theoretical approaches are not mutually exclusive. However, in contrast to *longue durée* theories, which focus too much on countries, he suggests concentrating on organisations, and highlights strong religious, imperial, and other organisations that had strengthened in the Middle Ages and played an extremely important role in building the nation-states later. The Balkans appear in several chapters of the book, perhaps not regardless of the author's provenance. One of the most astonishing findings is that despite the popular belief, Balkan 'national movements' in the first half of the 19th century, such as the First Serbian Uprising (1804–1813), were not 'national' at all. For example, the Serbian Uprising much more has to be considered as social rebellion against the renegade Janissary officers of the Ottoman Empire. Malešević argues that the vast majority of Serbian society at the time was not at all receptive to nationalist ideals and the Sanjak of Smederevo, where most of the Serbs lived, was lacking in institutions, such as national administration, education system or intellectual life that could have provided the basis for the creation of a nation-state. The uprisings of the early 1800s in the Balkans can be seen as a superimposition of geopolitical games of surrounding empires and dissatisfactions with local rulers rather than 'national' movements. On the other hand, the organisational power of the Orthodox Church, which operated under Ottoman rule, contributed a lot to the creation of the nation-

state, which, in addition to intensive religious life, also operated schools and played a major role in the organisation of everyday life.

The book provides similar curiosities from Bulgaria, Greece and Ireland. Moreover, in a separate chapter, Malešević analyses the problem of 'small nation' and compares nationalisms in Ireland and Serbia, two nations with small areas and populations. He tries to explore the reasons why in one context the adjective 'small' carries positive connotations, while in the other, it is being seen as a national tragedy and the greatness of the glorious past is being idolised in national narratives. Whereas the successful economic integration of Ireland is characterised by the 'Celtic Tiger' metaphor, Serbia is rather constructing an imperial past covering a large geographical area in the Middle Ages in contrast to the contemporary small one. These approaches are also well known in the countries of the Carpathian Basin. Behind the metaphors of the 'Tatra Tiger' in Slovakia or the 'Pannonian Puma' in Hungary (Pogátsa, Z. 2009; Kaneva, N. 2012), there is a belief in success, while the glorification of the past is also a characteristic of these countries. Finally, Malešević provides in his volume an analysis of the connections between globalisation and nationalist subjectivities as well as a study about the relations between grounded nationalisms and the privatisation of security.

Still, the book, while examining nationalism from various angles, also has some shortcomings. The most striking example are repetitions, which stem from the fact that the author used his earlier works while compiling and writing the current title. Besides, although it is true that the Malešević investigates a significant number of theories, which makes the book exciting, the author cannot present all theories in their completeness. Thus, in some cases, for example, the theories of Giddens, Beck or Baumann are presented in an oversimplified way, so it is unchallenging to make counter-arguments against them. In addition, certain theories are left out of the discussion, such as postnationalism and transnationalism, but the most painful lack is that of regionalism. Malešević's attention is avoided by regions of nation-states (see Antonsich, M. 2009 for more details) as well as ethnic-national minorities (e.g. Catalans, Silesians, and Kurds) along with their willingness to exist within (or outside) the nation-state. The writer attaches enormous importance to "emancipatory, egalitarian and fraternal messages" (p. 277) of nationalism, but the perspectives of minorities related to this nation-centric, dominant sense remains unstudied. Thus, he may have a blind spot when it comes to national minorities.

In spite of these shortcomings, the theoretical framework outlined by the author is not only complex but also well applicable because it makes nationalisms universally comparable, whereas it avoids relativism and particularism. With the assistance of this theory, individual phenomena and processes can be explained, since it provides a utilitarian conceptual scaffold for them. The author emphasises that "the strength of nationalism resides in its ground-ness, the well-entrenched and firmly embedded nationalisms are generally less visible to the naked eye… Once fully grounded, nationalism becomes second nature, a set of largely unquestioned beliefs and social practices that underpins equally the institutional dynamics and everyday life of ordinary individuals in the contemporary world" (p. 279). Therefore, the book is recommended for reading to all those who are interested in the history and contemporary processes of nation-states and nationalism. It is especially valuable for historians, social scientists, and geographers, and also for those who wish to gain a profound insight into contemporary social phenomena related to nationalism.

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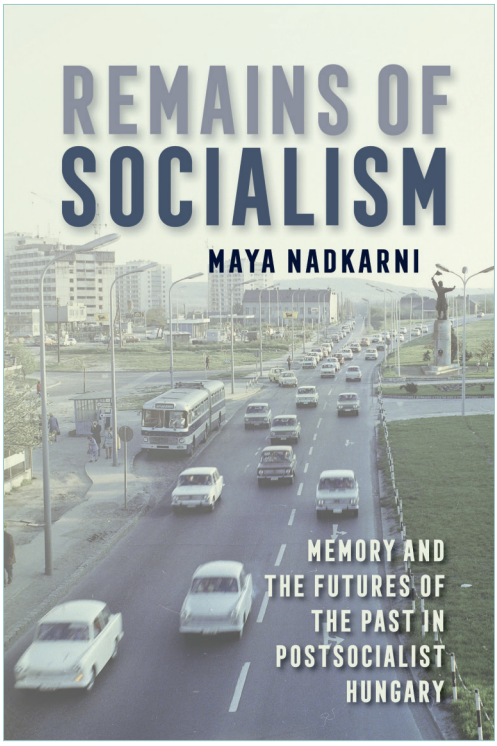
Nadkarni, M.: Remains of Socialism: Memory and the Futures of the Past in Postsocialist Hungary. Ithaca, Cornell University Press, 2020. 234 p.

More than three decades have passed since 1989, yet there seems to be no consensus about how Hungarians should collectively remember the socialist era. From the optimistic initial phase of transition throughout the pompous representative ceremonies for the anniversaries of state foundation and 1956, to the recent illiberal turn, *Remains of Socialism* takes us for quite a ride mapping out the many changes in narratives about the past.

Pierre Nora (1989) suggests considering sites of memories (*lieux de memoire*), which are constantly present in personal and collective memory, enhancing identities and therefore forming an integral part of the development of nationalism. The work of Nora (and also his critics) spawned a surge of interest in researching the politics of memory and memory studies in general, but also intrigued historical and cultural geographers. Unlike many other trends which local science only adopts with a considerable lag, this approach was quickly followed by Hungarian researchers too. For a long time, the field was dominated by researching Holocaust trauma, but recently there seems to be a turn from loss, dysphoria and mourning towards more positive experiences. This allows for a more nuanced study of the postsocialist context since it is crucial to understand "the creative and positive meanings with which [citizens] endowed their socialist lives—sometimes in line with the announced goals of the state, sometimes in spite of them, and sometimes relating to them in ways that did not fit either-or dichotomies" (Yurchak, A. 2005, 9).



One takeaway from this book is that remembrance of socialism was always relative and ambiguous – that also means that, by extension, our own memories of the socialist past are under constant transformation. We can also conclude that the former influences the latter. Adopting the language usually deployed in the postsocialist setting (ruins, ghosts, etc.) would risk "limiting our attention to only the negative experiences of the past's remainders" (p. 6). To avoid this, the author conceptualises *remains* as „matter out of time," referencing Mary Douglas's presentation of dirt as "matter out of place" (Douglas, M. 2002, 36), stressing this malleable and shifting nature of memories. Remains of socialism were not only kept from being buried, but rather kept alive to scrutinise, hold as 'the' problem that previous administrations neglected to solve, while "the conditions for "entering Europe" and becoming fully "modern" included the demand that Eastern Europe sacrifice previous historical narratives (whether communist or nationalist) and disavow the meaningfulness of earlier lifeways" (p. 12). Although the presented case studies are exclusively Hungarian, the analysis can be interpreted more universally, essentially as "a study of modern historical subjectivity and the overlapping, incommensurable, and conflicting narrative horizons that compose it" (p. 13).

Nadkarni spent years in the country teaching English in rural villages—this explains how she could handle ethnographic research dealing with controversial topics like politics and remembrance of socialism (which often leads to heated debates even among family members and friends in Hungary). The end result is a testimony of extensive fieldwork culminating in countless interviews with voters of different age from Hungary (recruited during random meetings during everyday life), and also with those from the political and cultural elite. She also consulted the relevant archives and contemporary publications, analysed events, especially scandals in detail, essentially performing a very detailed Foucauldian discourse analysis. The stories presented are often familiar – I have either heard some of them before, since my own family shared similar memories with me, or for most of them I have been alive to experience it growing up in post-socialist Hungary.

For geographers, the volume should be considered as a companion piece to Czepczynski's *Cultural Landscapes of Post-Socialist Cities* (2008), which contributes to similar topics, albeit about post-socialist countries in general from a decidedly more geographical perspective. Each chapter revolves around a particular form of remains (be it a material object, or cultural remainders). The first three chapters share a pattern of optimism for a successful present by mastering the past, while the remains described in the latter three chapters warn us about the looming danger of communism creeping back.

The political regime change in 1989 brought a physical change towards a new, democratic and capitalist landscape. But while the replacement of iconic socialist buildings, infrastructure and vehicles were costly, impractical and slow, one of the early performative acts of transformation was the removal of socialist symbolism from the country. Discarding them simultaneously labeled these kinds of remains as unsatisfactory or even unpleasant to the eyes of the new ideology. Chapter 1 (*Banishing Remains: The Statue Park Museum*) shows how political groups rallied to 'spring clean' by renaming streets and removing statues associated with the toppled ideology.

Nadkarni argues that by moving these statues from important sites to the outskirts of the city into a small theme park of socialist history was not a response to public demand, but rather reaction to the lack of such demand by trying to maintain control over it. Perhaps the most iconic (and geographically interesting) case was the removal of the statue of Ostapenko—but dealing with an important landmark with heavily shifted cultural connotations was „a more ambivalent task than disposing of countless Lenins" (p. 36). The statue, erected near the city limits at the end of the highway leading to Lake Balaton, quickly lost its original meaning and entered urban culture as a positional marker, a meeting point and a symbol of travel. Therefore, even the physical relocation could not remove the remains of the statue of Ostapenko: the local McDonald's inherited the name (and closed the circle of Disneyfication).

In Chapter 2 (*A Hole in the Flag*), Nadkarni highlights the incoherent outcome of constant political battles among the new democratic forces for the legacy of 1956 that reduced its memory to a "stockpile of decontextualized events and symbols" (p. 168). After the regime change, both the nation and its history had to be reinvented by those in power (Anderson, B. 1983; Hobsbawm, E.J. and Ranger, T.O. 1983), and these modernist concepts about nationality are inherent in approaches to reconstruct the narrative of the failed 1956 rebellion against the Soviets, and Fidesz (Young Democrats) party's commemorative efforts culminating in the Millennium celebrations. The goal of these political battles with strong representative roles was to invert the national narrative of Hungary as a perpetual victim, with "a continuous history of executions, exiles, and political suicides. The normal public rituals of Hungarian history are, accordingly, not victory parades but funerals and reburials" (Rév, I. 2013, 41–42).

After attempts to distance the past by removal of the old and silence the past by more suitable cultural alternatives, a third way of remastering is presented in Chapter 3 (*Nostalgia and the Remains of Everyday Life*). *Eastalgy* (*Ostalgie*) towards the former GDR in Germany became a strong cultural trend from the late 1990s, and other postsocialist countries followed suit. This longing for the simpler and safer good old times is not a postsocialist specialty of course, but it adds to the complexity of how these remains could be handled. By reintroducing products from their childhood, the objects of nostalgia could not only be juxtaposed to the new ways of living but could also define the consumer in a capitalist society for the first time.

Following the 1990s, the period of change seemed to be taking too long, so people began to become disillusioned with the experience of transition. Sensing the downturn in support Fidesz started to return to the narrative of victimisation by repositioning themselves as those, who can overcome the burdens of the socialist past, rather than merely overwriting it. By the end of its first cycle from 1998 to 2002, Fidesz experimented with a new approach to tackle the past. In Chapter 4 (*Recovering National Victimhood at the House of Terror*), Nadkarni explores how the governing coalition revived remains to warn about the looming threat of communism. In a building where first the extreme right Arrow-Cross Party, then the ÁVO, the State Defense Department of the Sovietised Hungarian State Police, held and tortured political prisoners, the museum opened just in time before the finish of the 2002 election campaign—with previously unexperienced emphasis on immersion. Viktor Orbán, the prime minister hoping for a reelection, described the events as „locking the past behind bars." With the main political opponents being the Hungarian Socialist Party (MSZP), Fidesz presented the elections as a moral battle between those who looked into the future and those who resembled the oppressive past.

The motif of unaddressed problems of the past never going away can be found in the case of former informers of the socialist regime, sparking heated debates about accountability throughout the 2000s. Chapter 5 (*Secrets, Inheritance, and a Generation's Remains*) charts how the conflict in families and between generations led to the reconceptualisation of socialist remains to avoid reproducing them.

At the end of the second postsocialist decade, many events called attention to the failure to fully transition. The fiftieth anniversary of 1956 saw mass demonstrations against the socialist government after prime minister Ferenc Gyurcsány's confession to lie in order to win the election was leaked to the media. Less than two years later, the severe effects of the

global financial crisis led to the bailout of the country by the IMF. These traumas led to the landslide victory of Fidesz in the 2010 elections, but also fuelled the view that the remains of socialism are still present as an obstacle that prevented Hungarians to live a fully normal life. Chapter 6 (*A Past Returned, A Future Deferred*) concludes that the history of communism might still have not completely finished.

After a period of disenchantment with the transition, which should not have led to such political and economic turmoil, Hungary had to find new ways to overcome old problems in the wake of joining the European Union, and once again, victimisation during the socialist past proved to be an obvious choice to highlight the dangers of the present. The success of Fidesz during the 2010 elections provided legitimity to their efforts to close the chapter of Hungarian socialism once and for all. Now a populist party leaning towards the right wing, their strongly anticommunist rhetoric seemed contradictory to many of their actions, which according to the opposition brought back many authoritarian elements to the detriment of the 'failed' democratic transition. This provides a comfortable analogy in the former Soviet aggression in multiple—either by comparing it to the European Union, like the ruling party often mentions, or to Fidesz, like the opposition does. This illiberal way therefore also keeps the remains of socialism alive after more than three decades of transition.

Botond Palaczki[1]

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