ACTA GEOGRAPHICA SLOVENICA

GEOGRAFSKI ZBORNIK

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SLOVENSKE AKADEMIJE ZNANOSTI IN UMETNOSTI
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ACTA GEOGRAPHICA SLOVENICA

GEOGRAFSKI ZBORNIK

62-1

2022

Založba ZRC

LJUBLJANA
2022

ACTA GEOGRAPHICA SLOVENICA

62-1
2022

ISSN: 1581-6613
UDC: 91
2022, ZRC SAZU, Geografski inštitut Antona Melika

Issued by/izdajatelj: Geografski inštitut Antona Melika ZRC SAZU
Published by/založnik: Založba ZRC

Address/naslov: Geografski inštitut Antona Melika ZRC SAZU, Gosposka ulica 13, p. p. 306, SI – 1000 Ljubljana, Slovenija

The articles are available on-line/prispevki so dostopni na medmrežju: http://ags.zrc-sazu.si (ISSN: 1581–8314)

Ordering/naročanje: Založba ZRC, Novi trg 2, p. p. 306, SI – 1001 Ljubljana, Slovenija; zalozba@zrc-sazu.si

Annual subscription/letna naročnina: 20 € for individuals/za posameznike, 28 € for institutions/za ustanove
Single issue/cena posamezne številke: 12,50 € for individuals/za posameznike, 16 € for institutions/za ustanove

Cartography/kartografija: Geografski inštitut Antona Melika ZRC SAZU
Translations/prevodi: DEKS, d. o. o.
DTP/prelom: SYNCOMP, d. o. o.
Printed by/tiskarna: Birografika Bori
Print run/naklada: 400 copies/izvodov

The journal is subsidized by the Slovenian Research Agency and is issued in the framework of the Geography of Slovenia core research programme (P6-0101)/Revija izhaja s podporo Javne agencije za raziskovalno dejavnost Republike Slovenije in nastaja v okviru raziskovalnega programa Geografija Slovenije (P6-0101).

The journal is indexed also in/revija je vključena tudi v: Clarivate Web of Science (SCIE – Science Citation Index Expanded; JCR – Journal Citation Report/Science Edition), Scopus, ERIH PLUS, GEOBASE Journals, Current geographical publications, EBSCOhost, Georef, FRANCIS, SJR (SCImago Journal & Country Rank), OCLC WorldCat, Google scholar, and CrossRef

Design by/Oblikovanje: Matjaž Vipotnik

Front cover photography: Large avalanches like the January 2021 »twin avalanche« in the upper Soča Valley that reach the valley floor will be unavoidable in the Alps in the future, as climate warming actually triggers them, contrary to expectations (photograph: Jure Tičar).
Fotografija na naslovnici: Velikim snežnim plazovom, kakršen je bil »dvojček« januarja 2021 v Zgornjem Posočju, ki dosežejo dolinsko dno, se v Alpah tudi v prihodnosti ne bomo izognili, saj jih otoplitev podnebja, nepričakovano, celo povzroča (fotografija Jure Tičar).

ACTA GEOGRAPHICA SLOVENICA

ISSN: 1581-6613
UDC: 91
Number: 62-1
Year: 2022

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Acta geographica Slovenica, 62-1, 2022, 7–20

FRACTAL ANALYSIS OF SPATIO-TEMPORAL CHANGES OF FOREST COVER IN ISTANBUL, TURKEY

Derya Ozturk

DERYA OZTURK

Pressure of rapid urbanization on forests in Turkey.

DOI: https://doi.org/10.3986/AGS.10206
UDC: 711.14:630(560)
COBISS: 1.01

Derya Ozturk[1]

Fractal analysis of spatio-temporal changes of forest cover in Istanbul, Turkey

ABSTRACT: In this study, the spatio-temporal changes in forest cover in Istanbul, one of the provinces with the most changes in forest areas in Turkey due to the pressure of urbanization and industrialization, were investigated using fractal analysis. The areal changes and changes in spatial patterns were determined to assess the spatio-temporal changes in the period 2000–2017. Fragmentation/compactness and heterogeneity/homogeneity of forest cover were determined by fractal dimension and lacunarity index, respectively. The results show that the forest areas have significantly decreased and become more fragmented and heterogeneous. In conclusion, this study reveals that fractal analysis can provide considerable information in the examination and interpretation of spatial changes in forest areas.

KEY WORDS: fractal analysis, fractal dimension, lacunarity index, spatio-temporal changes, forest cover, land use change

Fraktalna analiza prostorsko-časovnih sprememb gozdnatosti v Carigradu v Turčiji

POVZETEK: V članku s fraktalno analizo raziskujemo prostorsko-časovne spremembe gozdnatosti v Carigradu, eni od turških pokrajin z največjimi spremembami gozda zaradi pritiska urbanizacije in industrializacije. Za oceno prostorsko-časovnih sprememb v obdobju 2000–2017 smo ugotavljali spremembe površine gozda in prostorskih vzorcev gozdnih zemljišč. S fraktalno analizo oziroma indeksom lakunarnosti smo določili razdrobljenost/kompaktnost ter heterogenost/homogenost gozdne pokrovnosti. Rezultati so pokazali, da so se gozdne površine znatno zmanjšale, obenem pa postale bolj razdrobljene in raznolike. V sklepu razkrivamo, da lahko fraktalna analiza zagotavlja precej informacij pri preučevanju in razlagi prostorskih sprememb na gozdnih območjih.

KLJUČNE BESEDE: fraktalna analiza, fraktalna dimenzija, indeks lakunarnosti, prostorsko-časovne spremembe, gozdna pokrovnost, sprememba rabe zemljišč

The article was submitted for publication on June 4th, 2021.
Uredništvo je prejelo prispevek 4. junija 2021.

[1] Ondokuz Mayis University, Department of Geomatics Engineering, Samsun, Turkey
dzozturk@gmail.com (https://orcid.org/0000-0002-0684-3127)

1 Introduction

Forests are natural resources that provide a wide range of ecosystem services (Nunoo 2008). Forest areas are being changed into other land use types such as agricultural land, settlements, roads etc. due to urbanization and industrialization. A decrease in forest areas has adverse impacts on the forest ecosystem and the whole ecological environment associated with the forest ecosystem (Chakravarty et al. 2012; Balthazar et al. 2015). A decrease in forest areas also has a strong negative impact on climate. Other adverse effects are the increase in the negative effects of hydro-meteorological disasters such as erosion, floods, landslides, and a decrease in biodiversity (Atmiş et al. 2007; Drăghici et al. 2017).

Since drastic changes in forests affect the overall ecological balance, it is crucial to determine changes, identify the causes of the changes, and develop effective management strategies (Drăghici et al. 2017). In this context, information technologies have been used effectively in monitoring forest areas, in recent years. The term of digital forestry, emerging with information technologies, is defined as science and technology that includes acquisition, integration, query, and analysis of digital data and information to ensure forest sustainability (Zhao et al. 2005; Ianăş and Germain 2018).

Remote sensing and Geographic Information System (GIS) technologies are very important in digital forestry. Remotely sensed satellite imagery offers significant advantages over traditional ground survey of forests with the characteristics of fast and inexpensive data acquisition of large areas with a synoptic view, monitoring of changes with the repetitive image acquisition and observation of the same location, easy integration with other GIS layers and maps, provision of data for inaccessible areas, and creation of historical data (Jovanović et al. 2018). With its spatial data analysis, simulation and decision support system facilities, GIS offers significant advantages in forest ecosystem management, forest fires control, silvicultural activities, and planning forest access roads (Shao and Reynolds 2006; Reddy et al. 2015).

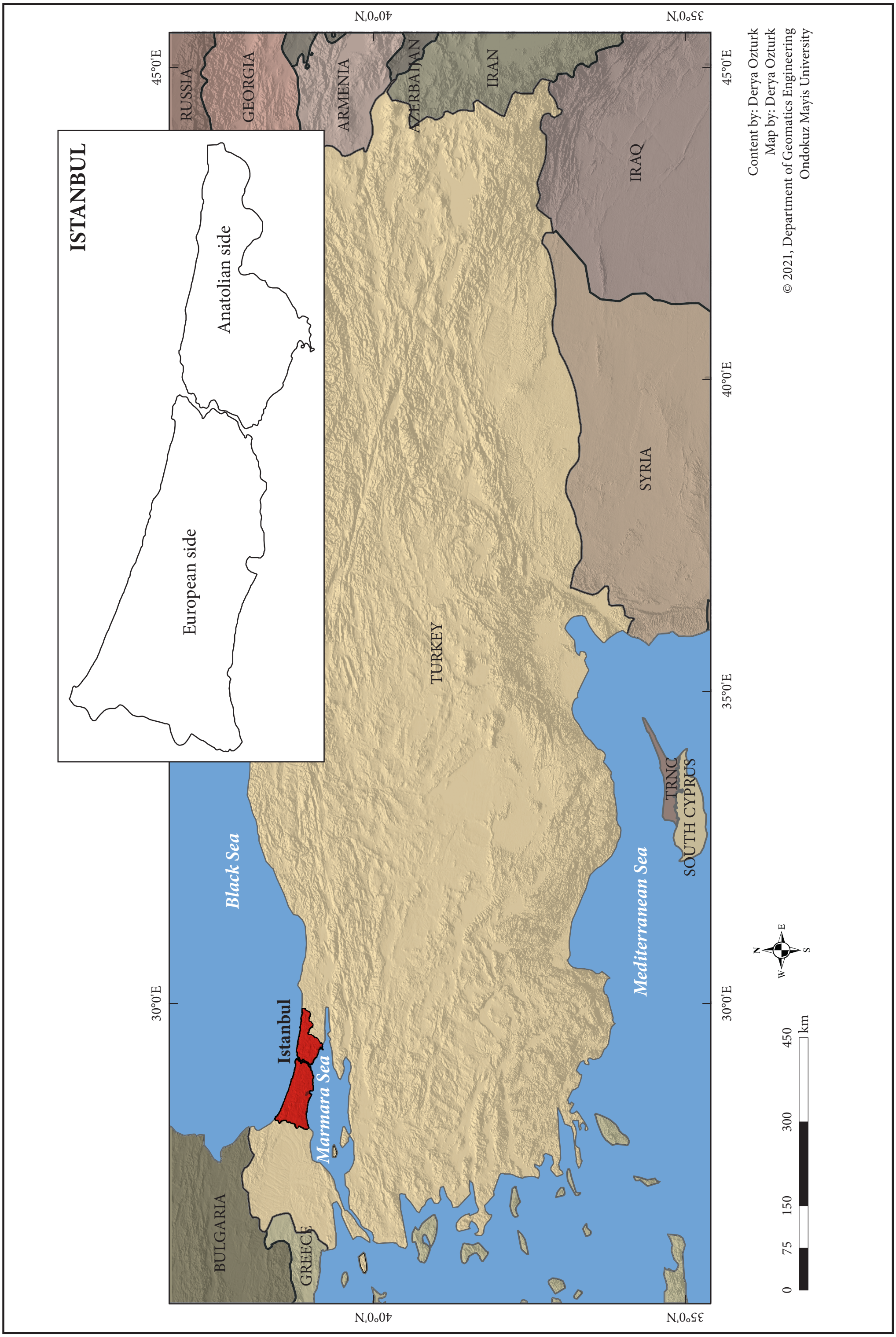
The rapid developments in GIS have enabled spatial data to be examined with more innovative perspectives. In this context, fractal analysis, an effective tool for identifying and analyzing the irregularities of objects, events, and phenomena, has recently been integrated into GIS to study the spatial pattern of objects in many subjects such as urbanization (Li et al. 2011; Tannier et al. 2011; Terzi and Kaya 2011; Ozturk 2017; Purevtseren et al. 2018; Man and Chen 2020), transportation (Lu and Tang 2004; Sun et al. 2007; Dasari and Gupta 2020; Karpinski et al. 2020; Sahitya and Prasad 2020), and geology (Wang et al. 2012; Pourghasemi et al. 2014; Ni et al. 2017; Sun et al. 2017; Yang et al. 2019). Although fractal analysis has the potential to improve the accuracy of measurement and identification of forest areas (Lorimer et al. 1994), very few studies have been conducted on the use of fractal analysis in forest areas. To quantify the landscape pattern and dynamics is necessary to monitor and evaluate the ecological consequences of the changes in spatial usage (Tian et al. 2007; Polenšek and Pirnat 2018; Foški 2019). Fractal dimension and lacunarity index are calculated within the scope of the fractal analysis. For forested areas, deforested areas, and afforested areas, the fractal dimension shows the degree of fragmentation/compactness and the lacunarity index measures the degree of spatial heterogeneity/homogeneity (Drăghici et al. 2017).

Due to anthropogenic activities, Istanbul is one of the provinces that experienced the most changes in forest areas in Turkey. In this study, the spatial changes of forest cover during the period 2000–2017 in Istanbul were examined based on fractal analysis and GIS. Global Forest Change data generated based on the analysis of Landsat satellite images were used in the analyzes. Areal and spatial changes were determined in the GIS environment and the spatial pattern of forest cover for the years 2000 and 2017, deforested and afforested areas in the period 2000–2017 were examined by fractal analysis, and the changes were discussed.

2 Study Area: Istanbul, Turkey

Istanbul (Figure 1) is located between 28°01'–29°55' east longitude and 40°28'–41°33' north latitude. It is located on a peninsula surrounded by the Black Sea, Marmara Sea, the Bosphorus, and the Golden Horn. The Bosphorus connects the Black Sea to the Marmara Sea, separates Asia and the European continent, and divides Istanbul into two regions: the European side and the Anatolian side (Dogan 2013).

Figure 1: Location of Istanbul. ➤ p. 10


ISTANBUL
Anatolian side
European side
RUSSIA
GEORGIA
ARMENIA
AZERBAIJAN
IRAN
IRAQ
SYRIA
TURKEY
TRNC
SOUTH CYPRUS
Black Sea
Istanbul
Marmara Sea
Mediterranean Sea
BULGARIA
GREECE
30°0'E
35°0'E
40°0'E
45°0'E
35°0'N
40°0'N
0 75 150 300 450 km
N E S W
Content by: Derya Ozturk
Map by: Derya Ozturk
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Ondokuz Mayis University

According to the data from Turkish Meteorological Service, the average annual precipitation in Istanbul is 817.4 mm, and the average temperature is 14.4° C for the measurement period 1929–2017 (Official Statistics 2019). Istanbul has 39 administrative districts, 14 of which are on the Anatolian side and 25 on the European side (Dogan 2013). The European side has an area of 3546 km^2 and the Anatolian side has an area of 1904 km^2 (Provincial and district surface areas 2018).

Its geographical location has given Istanbul strategic importance and led it to be one of the most populous cities in the world (Karaburun et al. 2010). According to Address Based Population Registration of the Turkish Statistical Institute, the population, which was 11.08 million in 2000, reached 15.46 million in 2020 (Statistics 2021). In metropolitan cities with rapid population growth, such as Istanbul, it becomes difficult to protect natural areas. Forest areas are being destroyed in Istanbul due to urbanization and industrialization pressures (Çakir et al. 2008; Karaburun et al. 2010).

3 Data and methods

In this study, spatio-temporal changes in forest cover during 2000–2017 were determined by overlay analysis and cross-tabulation; spatio-temporal changes of spatial pattern characteristics were determined by fractal analysis. In fractal analysis, fractal dimension and lacunarity index were calculated. In this way, the degree of fragmentation and dispersion of the forest areas during 2000–2017 was determined, and thus how much forest areas were affected by deforestation and afforestation. In addition, the fractal dimension and the lacunarity index were calculated for deforested and afforested areas. All analyzes were performed separately for the European side, Anatolian side, and for the whole of Istanbul.

Forest area boundaries for 2000 and 2017 were obtained from the Global Forest Change database with a pixel size of 1 arc second. Tree cover data are defined as canopy closure for all vegetation with height more than 5 m. Values are encoded in the range of 0–100 as a percentage on the pixel base (Global Forest Change 2000–2017 Database 2018). In this study, a threshold of 30% was chosen for the 2000 tree canopy cover data, and areas with a canopy closure value greater than 30% were identified as »forest cover« and the other areas were identified as »other areas«. Then, forest cover was coded as 1 and other areas as 0, and binary images were generated for fractal analysis. Forest cover for the year 2000 was updated with loss and gain data and the forest cover was determined for the year 2017. The binary images for fractal analysis are shown in Figure 2.

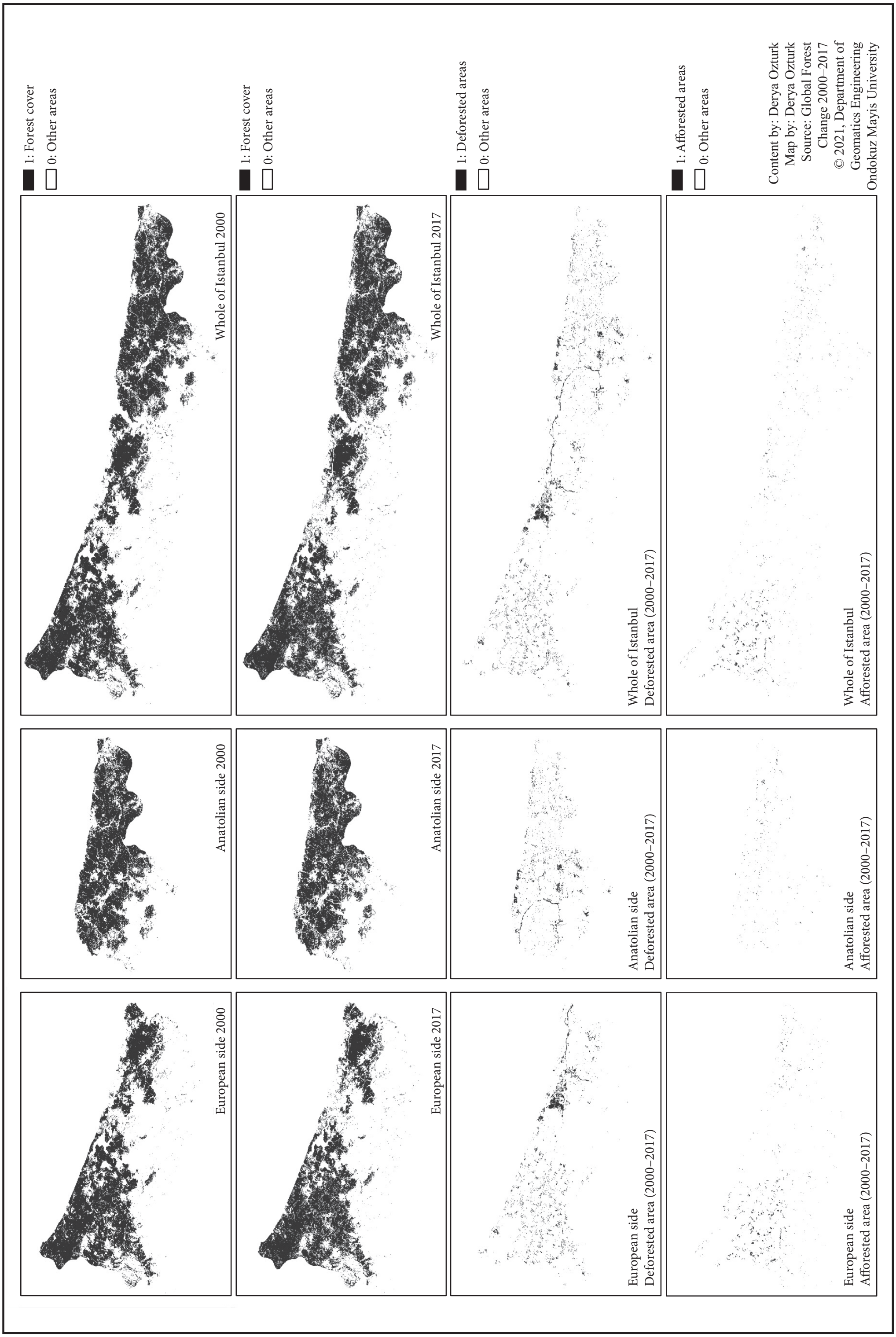
The degrees of fragmentation/compactness and heterogeneity/homogeneity were determined using the binary images for the forest areas 2000 and 2017 and for the deforested and afforested areas in the period 2000–2017. The binary coding of the images, the calculations of the areal changes, and the analyzes of the spatial changes with overlay and cross-tabulation were performed using ArcGIS 10.0 software (Esri, Redlands, CA), and the fractal analyzes for the fractal dimension and lacunarity index were implemented using ImageJ software (National Institutes of Health, USA) and the FracLac plugin.

3.1 Fractal analysis

In this study, fractal analysis was used to measure the changes in the spatial pattern of forest cover. For this purpose, fractal dimension was calculated by box-counting algorithm and lacunarity index was calculated by the gliding-box algorithm. In the fractal analyzes, the calculations were made using 5 different grid locations with a minimum grid size of 3 pixels and a maximum grid size of 45% of the image.

A fractal is a rough or fragmented geometric shape, that can be divided into parts, where approximately each part is a reduced copy of the whole (Jiang and Brandt 2016; Diaconu et al. 2017). The fractal dimension is beneficial in determining the irregularity or roughness of man-made and natural objects that do not conform to classical geometry (Drăghici et al. 2017) and measures the degree of irregularity, complexity, and fragmentation of a spatial structure (Oliveira et al. 2014; Diaconu et al. 2017). A lower fractal dimension represents a more compact object, while a higher fractal dimension represents a more complex object (Hu et al. 2015). The lacunarity index is complementary to the fractal dimension and measures the

Figure 2: Binary images for fractal analysis. ➤ p. 12


1: Forest cover
0: Other areas
1: Forest cover
0: Other areas
1: Deforested areas
0: Other areas
1: Afforested areas
0: Other areas
Content by: Derya Ozturk
Map by: Derya Ozturk
Source: Global Forest Change 2000–2017
© 2021, Department of Geomatics Engineering
Ondokuz Mayis University
Whole of Istanbul 2000
Anatolian side 2000
European side 2000
Whole of Istanbul 2017
Anatolian side 2017
European side 2017
Whole of Istanbul
Deforested area (2000–2017)
Anatolian side
Deforested area (2000–2017)
European side
Deforested area (2000–2017)
Whole of Istanbul
Afforested area (2000–2017)
Anatolian side
Afforested area (2000–2017)
European side
Afforested area (2000–2017)

heterogeneity/homogeneity of the spatial distribution of the object (Drăghici et al. 2017). Lacunarity is concerned with the distribution of gap sizes in a geometric object. A lower lacunarity index value represents a more homogeneous object, as it expresses gap sizes almost close to each other. In comparison, a higher lacunarity index value represents a more heterogeneous object since it expresses gap sizes that differ from each other (Dong 2000).

To calculate the fractal dimension using the box-counting algorithm, the most commonly used method for calculating the fractal dimension, the object is covered with grids (boxes) of different sizes, and the number of grids that cover all the object or part of the object is determined. The fractal dimension is calculated using the different grid sizes and the numbers of the filled grids depending on grid size. The calculation of the fractal dimension using the box-counting method is given in Equation 1 (Morency and Chapleau 2003; Peitgen et al. 2004).

$$D_B = (\log N_2 - \log N_1) / (\log S_2 - \log S_1) \quad (1)$$

Where D_B is a fractal dimension by box-counting, N is the number of the grid, and S is grid size.

To calculate the lacunarity index using the gliding-box algorithm, the most commonly used method for calculating the lacunarity index, an r x r-dimensional grid is placed in the upper left corner of the image. The number of pixels in the grid is determined. To calculate the number of full pixels for each position of the grid, the grid is systematically moved one column to the right, and when one row is complete, it continues on the next row (Allain and Cloitre 1991; Dong 2000). The Q(S,r) value is calculated by using Equation 2, where the total number of positions of the grid is N(r) and the number of grid positions with S full pixels in the r x r dimensional grid is S(s,r). Using the Q(S,r) and S values, the 1st and 2nd statistical moments (Z_1 and Z_2) are calculated as in Equations 3 and 4. The lacunarity index (Λ) is calculated using the 1st and 2nd statistical moments according to Equation 5 (Allain and Cloitre 1991):

$$Q(S, r) = n(S, r) / N(r) \quad (2)$$

$$Z_1 = \Sigma\, SQ(S, r) \quad (3)$$

$$Z_2 = \Sigma\, S^2Q(S, r) \quad (4)$$

$$\Lambda(r) = Z_2 / Z_1^2 \quad (5)$$

4 Results

The values of surface area, fractal dimension, and lacunarity index of forest areas on the European side, Anatolian side, and the whole of Istanbul in 2000 and 2017 and the amount of the change for the period 2000–2017 are shown in Table 1.

Table 1: Forest area (F), fractal dimension (D_B) and lacunarity index (Λ(r)) for 2000 and 2017, changes (Δ) in the period 2000–2017.

	2000			2017			2000–2017		
	F (km²)	D_B	$\Lambda(r)$	F (km²)	D_B	$\Lambda(r)$	ΔF (km²)	ΔD_B	$\Delta(r)$
European Side	1231	1.699	1.127	1151	1.715	1.227	–80	0.016	0.100
Anatolian Side	1018	1.743	0.673	950	1.745	0.700	–68	0.002	0.027
Whole of Istanbul	2249	1.698	0.876	2101	1.708	0.933	–148	0.010	0.057

Table 2: Surface area (F), fractal dimension (D_B), and lacunarity index ($\Lambda(r)$) of the deforested and afforested area in the period 2000–2017.

	Deforested			Afforested			Total loss ($F_{def} - F_{af}$)
	F_{def} (km²)	D_B	$\Delta(r)$	F_{af} (km²)	D_B	$\Delta(r)$	
European Side	114	1.537	2.126	34	1.470	2.961	80
Anatolian Side	78	1.585	1.103	10	1.394	1.340	68
Whole of Istanbul	192	1.558	1.419	44	1.458	2.769	148

Table 2 shows the surface area, fractal dimension, and lacunarity index of the deforested and afforested areas on the European side, Anatolian side, and the whole of Istanbul in the period 2000–2017.

According to Table 1, the forest area on European side was 1231 km² in 2000, and decreased to 1151 km² in 2017, while the forest area on the Anatolian side was 1018 km² in 2000 and decreased to 950 km² in 2017. Accordingly, the forest area was 2249 m² in 2000, and decreased to 2101 km² in 2017.

According to Table 2, 114 km² forest area was lost and 34 km² area changed as forest on the European side while 78 km² forest area was lost and 10 km² area changed as forest on the Anatolian side in the period 2000–2017. In this context, the loss is higher than the gain as the total loss was 80 km² on the European side, 68 km² on the Anatolian side and accordingly, the total loss for the whole of Istanbul is 148 km².

The spatial changes of forest areas on the European side, the Anatolian side, and for the whole of Istanbul in the period 2000–2017 are shown in Figure 2. The green color indicates the forest areas in both 2000 and 2017, the red color indicates the losses (non-forest areas in 2017 while they were in forest in 2000), and the yellow color indicates the gains (forest areas in 2017 while they were in non-forest in 2000).

The fractal dimension shows the degree of complexity of forest cover, it also explains how and to what extent forest areas are spatially fragmented by deforestation and afforestation. A higher fractal dimension indicates a more complex or disperse forest cover form. An increase in the fractal dimension indicates that the forest cover has become more complex and fragmented, and irregular uses have occurred. Similarly, the fractal dimension of deforested and afforested areas reveals the complexity of the spatial distributions of change. The lacunarity index shows the degree of heterogeneity of the spatial distribution of forest, deforested and afforested areas and is complementary to the fractal dimension. A higher lacunarity index indicates a more heterogeneous forest cover form. An increase in the lacunarity index indicates that the forest cover has become more heterogeneous. Similarly, the lacunarity index of deforested and afforested areas reveals the heterogeneity of the spatial distributions of change.

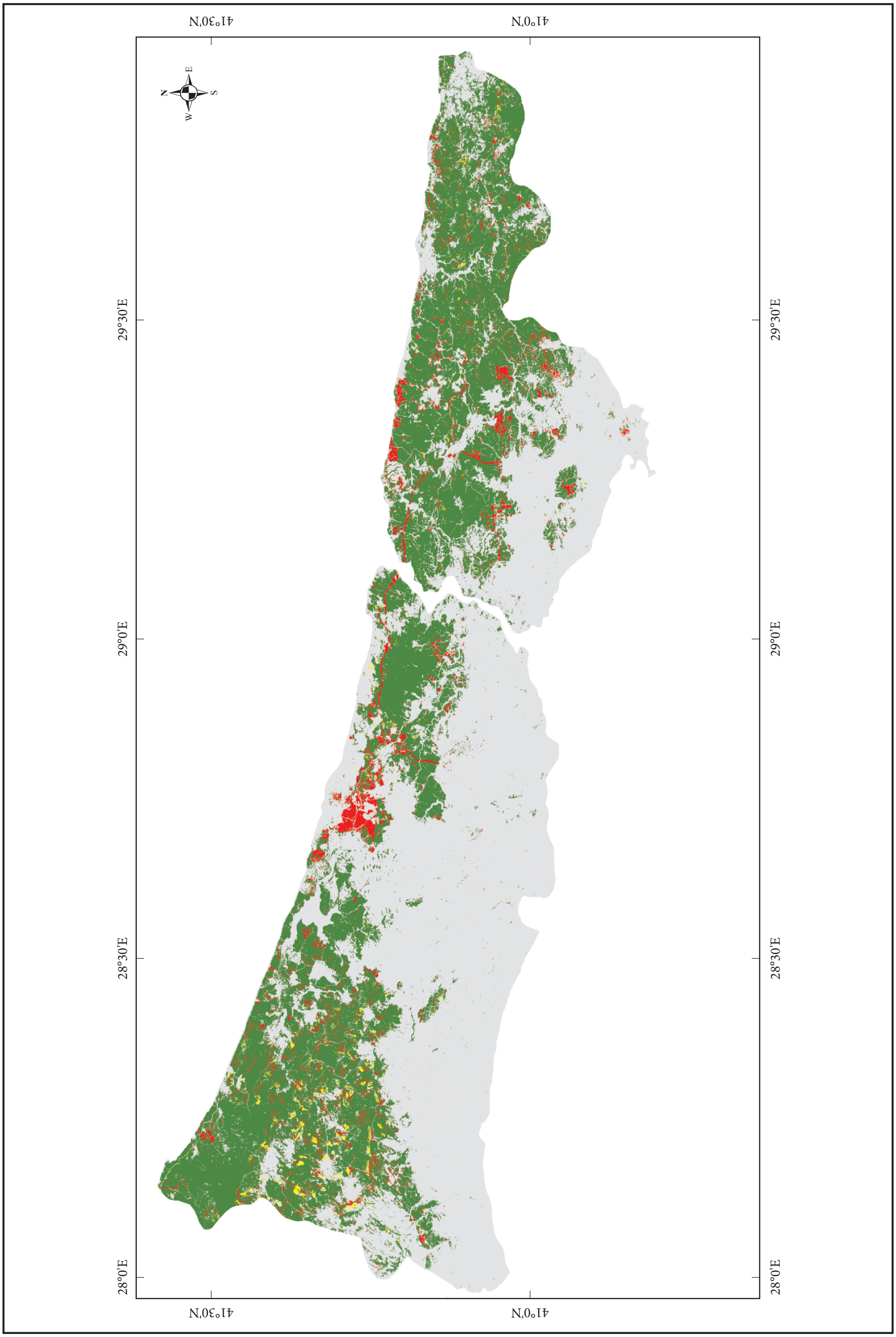
According to Table 1, the fractal dimension of forest areas on the European side was 1.715 in 2017, while it was 1.699 in 2000. The value of the lacunarity index was 1.227 in 2017, while it was 1.127 in 2000. According to Table 2, in the period 2000–2017, the fractal dimension was 1.537 and the lacunarity index was 2.126 for deforested areas, while the fractal dimension was 1.470 and the lacunarity index was 2.961 for afforested areas.

According to Table 1, the fractal dimension of forest areas on the Anatolian side was 1.745 in 2017, while it was 1.743 in 2000. The value of the lacunarity index was 0.700 in 2017, while it was 0.673 in 2000. According to Table 2, during 2000–2017, the fractal dimension was 1.585 and the lacunarity index was 1.103 for deforested areas, while the fractal dimension was 1.394 and the lacunarity index was 1.340 for afforested areas.

According to Table 1, the fractal dimension for the whole of Istanbul was 1.698 in 2000 and 1.708 in 2017, while the lacunarity of the forest areas was 0.876 in 2000 and 0.933 in 2017. According to Table 2, during 2000–2017, the fractal dimension was 1.558 and the lacunarity index was 1.419 for deforested areas, while the fractal dimension was 1.458 and the lacunarity index was 2.769 for afforested areas.

The fractal dimension increased by 0.016 on the European side and by 0.002 on the Anatolian side. These increases indicate that the forest areas have become more fragmented. The increase in fragmentation on the European side is higher than on the Anatolian side. The lacunarity index increased by 0.100 on the European side and by 0.027 on the Anatolian side. These increases indicate that forest areas have become more heterogeneous. The increase in heterogeneity on the European side is higher than on the Anatolian side.

Figure 3: The spatial change of forest cover in Istanbul. ➤


41°30'N
41°0'N
29°30'E
29°0'E
28°30'E
28°0'E
N
E
S
W

5 Discussion

Determining dynamics of the forest landscape is an important issue in terms of sustainable land and forest management (Çakir et al. 2008). Particularly in areas under urbanization and industrialization pressure, determining changes in the landscape in terms of both area and spatial characteristics is essential for monitoring and protecting forest areas in order to prepare effective development plans and sustainable forest management plans (Çakir and Özdemir 2015; Ren et al. 2019).

Migration from rural to urban areas, which started in the 1950s in Turkey, led to excessive population growth in Istanbul in a short period of time, especially after the 1980s (Işık 2005; Çakir et al. 2008). The natural resources in Istanbul started to be destroyed rapidly due to various reasons resulting from this rapid population increase. Urbanization and industrialization, which have developed in parallel with the population increase in Istanbul, have also led to significant changes in forest areas (Atmiş et al. 2007; Gökburun 2017).

In this study, forest areas were found to decrease by 6.5% on the European side, 6.7% on the Anatolian side, and 6.6% in the whole of Istanbul during period 2000–2017. These rates show that the decline of 5.4% reported by Karaburun et al. (2010) for the period 1987–2007 is still increasing, and the decline of forest areas continues. These changes in forest areas revealed a general downward trend in Istanbul.

In addition, in terms of spatial pattern features, forest fragmentation is the fragmentation of large, continuous, and compact forest areas (Bogaert et al. 2011), and spatial heterogeneity of forest is based on the gaps of different sizes (Buajan et al. 2017). Deforestation due to urbanization, road development, agricultural development, and forest fires generally leads to an increase in forest fragmentation and heterogeneity (Broadbent et al. 2008). Identification of the fragmentation/compactness and heterogeneity/homogeneity is essential in terms of species in the forest ecosystem and landscape characteristics (Bogaert et al. 2011; Peh et al. 2014).

Considering the results of the fractal analysis of this study, it can be summarized that the fractal dimension of forest areas on the Anatolian side is higher than on the European side in both 2000 and 2017. This shows that the forest areas on the Anatolian side are more fragmented and complex than those on the European side. The Anatolian side has more forest area in percentage than the European side and the percentage decrease in forest areas due to urbanization activities on the Anatolian side is higher than on the European side. This situation results in more fragmented forest areas. The lacunarity index is higher on the European side than on the Anatolian side in both 2000 and 2017, indicating that forest areas are more heterogeneous on the European side than on the Anatolian side. Moreover, for the European side, Anatolian side, and the whole of Istanbul, the fractal dimension and lacunarity index have increased during the period 2000–2017, which means that complexity and heterogeneity have increased due to deforestation. The amount of increase is greater on the European side for both fractal dimension and lacunarity index. This shows that the changes in the form of forest areas on the European side during the 2000–2017 period were greater than on the Anatolian side.

Fractal analysis has been used in some geographical studies related to forest change, deforestation, and afforestation. Andronache et al. (2016), Pintilii et al. (2016), Drăghici et al. (2017), Andronache et al. (2019), and Diaconu et al. (2020) obtained complementary interpretations for forest areas with the integrated use of fractal dimension and lacunarity index. Andronache et al. (2016) analyzed the change of forest areas for the period 2000–2012 in the North-Eastern Development Region in Romania, where large forest areas were converted to different land uses due to local economic pressure. The results of the analysis showed that the afforested areas were more compact and had more homogeneous arrangement than the deforested areas. Considerable differences were found between the deforested and afforested areas. The maximum difference was observed in Iaşi county, while the minimum difference was observed in Vaslui county. Pintilii et al. (2016) analysed the changes in Suceava-Cârlibaba in Romania for the period 2000–2013 and found that the deforested areas were more fragmented and heterogeneous. Drăghici et al. (2017) analyzed the changes in the forest areas in the Northern Carpathian Mountains for the period 2000–2014, and it was determined that the forest areas turned into a more complex and more heterogeneous structure. Andronache et al. (2019) performed the analysis of the deforested areas of the Apuseni Mountains for the period 2000–2014 and determined an increase in fragmentation and heterogeneity with a decrease in the tree cover area. Diaconu et al. (2020) analyzed the deforestation in the mountain area, the northern and central groups of the Eastern Carpathians for the period 2000–2017 and determined that deforestation causes the fragmentation of forests. Consistent with these studies, the fragmentation/compactness and heterogeneity/homogeneity degree could be evaluated separately using the fractal dimension and lacunarity index, respectively. When the results of the fractal analysis of deforested and afforested areas are examined, it is clear that the deforested areas are more fragmented and homogenous than the afforested areas for the European side, the Anatolian side and the whole of Istanbul. Notable differences were determined for the values of fractal dimension and lacunarity index of deforested and afforested areas. The difference between the fractal dimension of deforested and afforested areas is higher on the Anatolian side, while the difference between the lacunarity index is higher on the European side.

6 Conclusion

Protecting forests is vital for adapting to and mitigating climate change, protecting biodiversity and preventing natural disasters such as erosion, floods and landslides. Therefore, forest areas and changes should be monitored and necessary measures such as forest conservation and management plans should be taken.

In this study, the spatio-temporal changes of forest cover in Istanbul, Turkey, during 2000–2017 were examined. In addition to the changes in area, the spatial patterns of both forest areas and areas of change were investigated using fractal analysis. The results show that forest areas degraded by cutting trees due to urbanization and industrialization pressures have resulted in a decrease in total forest area and more fragmented and heterogeneous landscapes. The results of this study can be used to investigate possible interactions and transitions between forest, deforested and afforested areas, and the results contribute to the assessment of forest areas under pressure.

The evaluation of spatio-temporal changes of forest cover in Istanbul was carried out using the Global Forest Change database (2000 and 2017). The results of the study showed that the Global Forest Change database with a spatial resolution 1 arc second can be effectively used in the quantitative analysis of the spatial patterns of forest, deforested and afforested areas with the integration of GIS and fractal analysis, providing new and complementary information in addition to the traditional change detection studies. The results obtained provide additional information that can be integrated into forest land management and organization plans. Similar approaches can be adapted to land cover/use classes other than forests, and new information can be provided through innovative approaches to spatial analysis.

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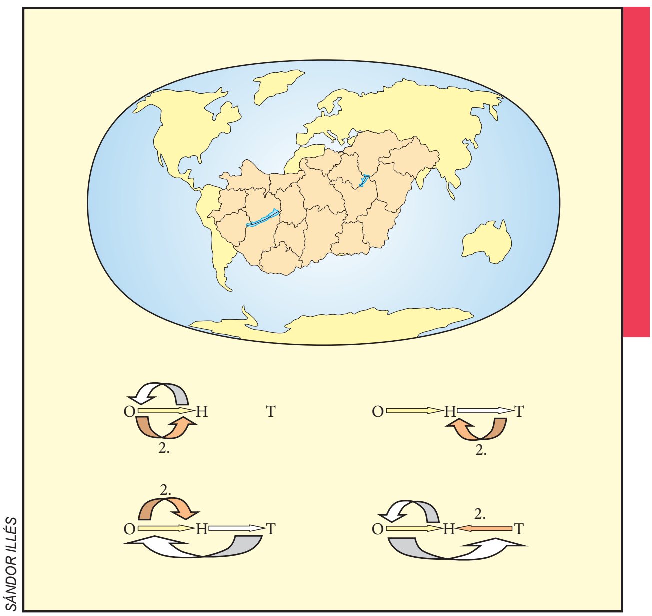
Acta geographica Slovenica, 62-1, 2022, 21–36

FROM FLUID MIGRATION TO STABLE CIRCULAR MIGRATION: A CASE STUDY FROM HUNGARY

Sándor Illés, Áron Kincses, Péter Simonyi



The circular migration system from the Hungarian point of view.

DOI: https://doi.org/10.3986/AGS.9537
UDC: 911.3:314.15(439)
COBISS: 1.01

Sándor Illés,[1] Áron Kincses,[2, 3] Péter Simonyi[1]

From fluid migration to stable circular migration: A case study from Hungary

ABSTRACT: This article provides insight into long-term international migration flows to Hungary from 2006 to 2012. The article distinguishes territorial systems embedded in migration and circular inflows. It discusses the concept of international circular migration from an inward perspective. Second, it studies the spatial and temporal changes in the structure of first-time international migrants and circulators using unique tables. Finally, it maps circular migration around this new immigration country. The patterns are generated by the practice of international migrants in combination with the migration policies of the receiving governmental actors. It concludes that circulators lend a sort of stability to the immigration system. Based on an analysis of statistical tables, circular immigration flows remained relatively stable even from a spatial perspective. Exploring stability in the context of circular migration is one of the main innovative approaches of this article.

KEY WORDS: international migration, circular migration, geographic system, economic crisis, Hungary

Od fluidne migracije do stabilne krožne migracije: Študija primera Madžarske

POVZETEK: Članek obravnava mednarodne migracijske tokove na Madžarskem od leta 2006 do 2012. Najprej smo opredelili teritorialne sisteme, ki so vključeni v migracijske tokove in podrobneje obravnavali koncept mednarodne krožne migracije. Nato smo na podlagi statističnih podatkov razčlenili prostorske in časovne spremembe v strukturi migrantov, ki so se na Madžarsko priselili prvič in krožnih migrantov. Na koncu smo migracijske tokove prikazali tudi kartografsko. Ugotovili smo, da na vzorce priseljevanja vpliva tako praksa mednarodnih migrantov kot tudi državna imigracijska politika. Raziskava je pokazala, da so krožni migracijski tokovi v prostorskem smislu relativno stabilni, s čimer prispevajo k stabilnosti sistema priseljevanja. Raziskovanje stabilnosti v kontekstu krožne migracije je ena glavnih novosti tega članka.

KLJUČNE BESEDE: mednarodne migracije, krožne migracije, geografski sistem, gospodarska kriza, Madžarska

The article was submitted for publication on January 24th, 2021.
Uredništvo je prejelo prispevek 24. januarja 2021.

[1] Active Society Foundation, 1095 Budapest, Hungary
dr.illes.sandor@gmail.com (https://orcid.org/0000-0001-9436-8719), sapi109@gmail.com

[2] University of Miskolc, Institute of World and Regional Economics, Budapest, Hungaryy
kincsreg@uni-miskolc.hu (https://orcid.org/0000-0002-9948-9525)

[3] Hungarian Central Statistical Office, Budapest, Hungary
aron.kincses@ksh.hu (https://orcid.org/0000-0002-9948-9525)

1 Introduction

International migration to Hungary was very limited during the communist era. The annual emigration flows of Hungarian citizens fluctuated between three and four thousand people after the 1956 revolution. In parallel, the annual immigration flow ranged between one and two thousand, dominated by return migration. Immigration of foreign citizens was sporadic and mainly came from communist countries due to labor and intermarriage, except for about one thousand refugees from Chile in 1973. In the sense of net international migration, Hungary was a country of emigration (Szoke 1992).

Quantitative and qualitative changes began in 1988, after four decades of Hungary's highly controlled migration regime. Due to the opening of borders and the collapse of communism in central and eastern Europe, the international migration flows took a radical turn. Hungary integrated into the regional and global international migration systems. The initial phase correlated with regional historical events, the collapse of East Germany, the last phase of Ceaușescu's rule in Romania, and the civil wars in the former Yugoslavia. In 1990–1991, the number of foreign immigrants to Hungary reached a peak of ten thousand people annually. After the fall of the Berlin Wall, the emigration of Hungarian citizens to the global west rose sharply, reaching an estimated one hundred thousand people by 2000. The annual influx of foreign citizens fluctuated between fifteen and twenty thousand people in the 1990s. Under the combined influence of immigration and the change of status of foreign residents, more than 150,000 long-term immigrants were living in Hungary at the turn of the millennium. Their share in the total population rose to over 1.5%. All in all, Hungary was classified as both a receiving and transit country, after having been a sending area for a long time (Dövényi and Tóth 2008).

From a quantitative point of view, the inflows and outflows continued in a similar way in the first half of the 2000s. Hungary's accession to the European Union in 2004 generated significant attraction for foreign immigrants. The share of immigrants increased to 2% within the total Hungarian population. Hungary became one of the new immigration destinations of foreign citizens among the countries of the former East Bloc (Egedy, Kovács and Szabó 2018). The label »new immigration country« pales in comparison (Winders 2014) with the massive emigration flows of Hungarian citizens since 2006 (Gödri, Soltész and Bodacz-Nagy 2014). Paradoxically, the immigration of foreigners has played a substitute role in relation to the country's population size, but to a lesser extent (Dabasi-Halász et al. 2019). All in all, the changeable nature of migration is having an effect in Hungary as well.

This study examines international circular migration using the host country database. Using the migration system approach and cartographic visualization, Hungary is conceptualized as part of the regional and global system, avoiding the approach of the simple national container (Wimmer and Glick Schiller 2002). The general aim of this article is to distinguish territorial subsystems embedded into migration and circulation inflows around Hungary. The specific aim is to quantify the influences of the last major economic recession on the spatial patterns of circulatory subsystems compared to the pre-crisis period.

The following section discusses the concept of international circular migration as a part of human spatial circular mobilities using some elements of migration systems theory. The rest of the article is organized as follows: first, the original dataset of international migration is clarified in relation to Hungary, as are the data-processing methods for international circular migration. Second, it analyzes the flows of first-time immigrants and circulators and visualizes circular immigrants (Dodge 2016) from a territorial point of view. Third, it discusses the impact of economic crises on migratory flows in general and their implications for the research findings. Finally, the article concludes by embedding the findings in possible explanatory frameworks and mechanisms. Other related topics, such as integration of immigrants and multilevel governance of migration, are beyond the scope of this article (King and Lulle 2016; Valenta and Drbohlav 2018; Durnik 2020).

2 Conceptualizing international circular migration

First, official statistical data are considered as facts in the form of discrete numbers. Later, the original data are transformed into circular and non-circular data and these new constructions are visualized cartographically. Moreover, the results in the maps are recognized as a new quality far from the simple statistical description and analysis. The maps reflect the complete and comprehensive situation of Hungary's international circular migration, reflecting the territorial systems around it during two time periods.

From the spatial, statistical, and demographic points of view, circulation consists of repeatable events, and the analysis of their parity (the number of times that a given individual migrates, or in other words serial migration) is a solvable problem. Multiple migrations of individuals show systematic features. Even the simplest migration system consists of at least two elements. A return migration, typical of this pattern, necessarily includes the previous migration (Nadler et al. 2016). Multiple moves of individuals link two or more geographical units. When a migrant explores more than one new territory, this is a case of onward or serial migration (Ciobanu 2015). Circular migration involves a system of more than two repeating spatial movements by an individual (White 2014).

The gross volume of international circular migration has undoubtedly increased, and many new types of circulation have begun to emerge (Czaika and de Haas 2014; Hugo 2014; Górny 2017). However, scholars have not yet reached a consensus on how to conceptualize the newly emerging multiple and recurrent migratory and circulatory movements (Skeldon 1997; UNECE 2016). Mobile people do not completely abandon their links with their countries of origin. They develop partial affiliations to their destination country through their work, housing, and other activities that are now part of their lifestyle (King 2002; Williams et al. 2011). Individuals might adopt a strategy of dual or multiple residence. In real life, this settlement strategy involves back-and-forth movements (Skeldon 2012). From a transnational perspective, advocated mainly by anthropologists and sociologists, this type of strategy results in an »in-between« situation for individuals (Glick Schiller and Salazar 2013; Khadria 2013). Scholars of the transnational-translocal nexus, mainly represented by geographers and demographers, emphasize the existence of double or multiple ties rooted in locality (Deshingkar and Farrington 2009; Brickell and Datta 2011; Cresswell and Merriman 2011).

Figure 1 illustrates multiple moves by individuals with three and four international migration events. The linked movements show systematic features at the individual level. For a sophisticated concept of circulating spatial movements, we developed the necessary elements of the circulation system from the perspective of the receiving country. The migration system is more than the sum of migration processes; that is, a set of moves associated with each other. The simplest example is the two-center system (Figure 1, part A). In this system, the flows occur between the two centers. In this two-residence case, the first movement is immigration to the destination country, with parity number 1. The return movement to the country of origin is nothing but a simple return migration. However, the next immigration of the same individual to the same receiving country has parity number 2 (in other words, second immigration). These three steps are sufficient for the

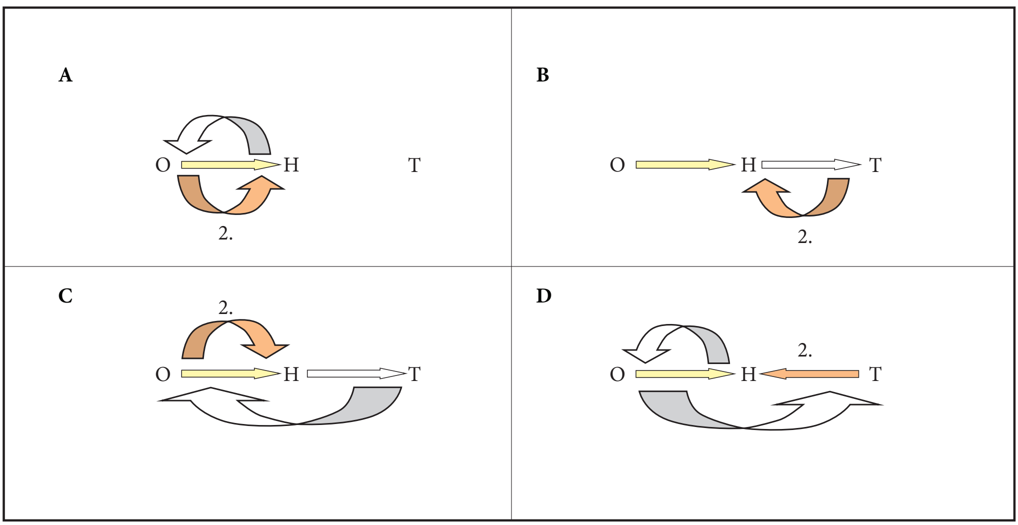


Figure 1: The concept of international circular migration from an inward perspective (O = origin country, H = Hungary, T = third country, 2 = second immigration to Hungary).

occurrence of circular migration between two poles. This is the simplest case. Other possible configurations of the circular system with at most two immigrations are drawn in Figure 1, parts B, C, and D.

In his seminal work, Akin Magobunje (1970) contributed to migration theory by creating the term *migration systems*. He dealt with rural–urban migration, and his scope was limited to one continent, Africa. The systems approach was extended to international migrations under the aegis of the United Nations (Kritz et al. 1992). The parts of the systems were countries that were favored by international migration flows. The creation of migration systems was fruitful from both the structuralist and constructivist perspectives (Panke 2018) and, as such, they became popular among geographers and researchers in other disciplines (Skeldon 1997; Hugo 2014). The availability of country-specific international immigration data opens up the possibility of constructing systems at regional, national, and subnational levels. This article explores a new magnet-county system in which we attempt to avoid the drawback of »methodological nationalism« by combining territorial series and mapping visualization (Wimmer and Glick Schiller 2002; Dodge 2016). The variety of real spaces combined with actors and practices (Kis 2019) creates different territorial levels of migration systems, which are presented in the concluding section.

Unfortunately, few circular movements have been documented quantitatively worldwide, making data collection essential (Parusel 2017; Weber and Saarela 2017). This case study seeks to enrich the knowledge of human circulation in a long-term international migration context. The focus is on Hungary as a receiving country and on the inward type of international circular migration of EU citizens and also third-country nationals. Naturally, Hungary is a unique case and may be an exception among countries worldwide. Nevertheless, its statistical system makes it possible to create a unique macro-level database on international circular migrants and to analyze it.

3 Data and methods

The data analyzed below are from the continuous registration system at Hungary's Immigration and Nationality Office. Those considered immigrants were natural persons with a legal right to residence in Hungary and the intention to stay there for at least one year. This dataset was sent as a national report to international organizations (the United Nations, European Union, and International Organization for Migration). The database had an unavoidable limitation. The dataset only contained information on immigrants for administrative reasons and interests. However, its fully comprehensive nature was its main advantage (Illés and Kincses 2018).

The innovative feature of the research was the reconstruction of these facts by serial numbers based on the demographic table method (Valkovics 2001). In the absence of a personal identification number, we used multilevel data processing to distinguish the immigrants studied in this article from the first-time immigrants in each year from 2006 to 2012. At the first level of disaggregation, we linked international immigrants with the same last name, first name(s), sex, date of birth, and place of birth. Spelling errors were corrected individually after automation. This was an initial step in identifying circular immigrants. The initial results were separated from the original dataset. In the next stage, we processed the residual dataset. In the second stage, we linked the residual immigrants with the same last name and first name(s) without diacritics on the letters, sex, date of birth, or place of birth.

This stage was necessary due to the wide variety of languages and the spelling errors made by the caseworkers that recorded the information with or without documents available for inspection. At the third stage, we shortened the last name to the first five letters without any diacritics. At this stage, we excluded the first name(s). This mass was combined with the sex, date of birth, and place of birth information. The next stages did not use the names, but included all other variables. Finally, after the seventh or eighth levels of comparing the residual datasets, we did not find the same individuals. All in all, we obtained a reconstructed new dataset. In this dataset, the natural persons that returned to Hungary different numbers of times (1+) were identified as first-time immigrants or as international circulators based on the serial numbers (2+).

This article also provides empirical evidence from the crisis period of 2009–2012. We use a one-year shift in the crisis interval due to the side effects of reaction time between potentially mobile people. We quantify the impact of the economic crisis on international circular migration relative to the pre-crisis period of 2006–2008, suggesting that the effects of the impact of the economic crisis are embedded in the differences in indicators between periods (Connolly 2012; Kiss 2012). We recognize that structural changes and the consequences of other forces play a role in the development of differences (Darvas 2011; Kocziszky,

Table 1: Number and share of immigrants (1+) and circulators (2+) by sex in Hungary between 2006 and 2012 (Source: Hungarian Central Statistical Office; authors' own calculations).

Year	All immigrants (1+)	Circulator (2+)	Circulator share (%)
Male			
2006	10,684	1,820	17.0
2007	12,753	1,904	14.9
2008	20,972	2,321	11.1
2009	14,589	2,150	14.7
2010	13,446	2,433	18.1
2011	12,576	1,901	15.1
2012	11,550	1,665	14.4
Total	96,570	14,194	14.7
Female			
2006	8,683	1,536	17.7
2007	9,854	1,560	15.8
2008	14,575	1,766	12.1
2009	10,993	1,686	15.3
2010	10,438	1,799	17.2
2011	9,938	1,453	14.6
2012	8,790	1,274	14.5
Total	73,271	11,074	15.1
Together			
2006	19,367	3,356	17.3
2007	22,607	3,464	15.3
2008	35,547	4,087	11.5
2009	25,582	3,836	15.0
2010	23,884	4,232	17.7
2011	22,514	3,354	14.9
2012	20,340	2,939	14.4
Total	169,841	25,268	14.9

Benedek and Szendi 2018). However, according to the literature, the biggest macro force was the effect of the economic crisis (Galgóczi, Leschke and Watt 2012; Roos and Zaun 2016). On the one hand, the upheaval affected the Hungarian population, and on the other hand it happened to internationally mobile people. Moreover, the rapid structural changes from year to year were partially eliminated by adding pre-crisis and downturn years. Given these methodological shortcomings, we interpret the spatial differences (Aalbers 2009) with great caution when separating the spatial systems of international circular migration around Hungary.

This article provides a range of information on sending countries that study their own international circular migrants. Further insights into the processes of long-term international circular migration could also be gained from the perspective of sending countries (Moreh 2014). However, it is difficult to measure international circular migration from the perspective of sending countries, and conducting cross-country comparisons (Strockmeijer, de Beer and Dagevos 2019) is even more complicated due to the inherent complexity of circulation. One possible solution is for international organizations to collect country-specific data on international circular migration and produce »mirror statistics« that develop the innovative practice of the United Nations (1998) on the simple bipolar flows of international migration.

4 Analysis and cartographic visualization

The statistical classification by citizenship and parity (number of entries) shows, in all the time periods studied, that circular migration was typical for citizens of neighboring countries such as Romania, Ukraine, and Serbia. These migrants were mainly from the Hungarian minorities living in these countries (Gödri, Soltész and Bodacz-Nagy 2014). According to Table 2, more than half of the international circular migrants in 2006–2012 originated from Romania (43.6%), Ukraine (9.3%), and Serbia (5.1%). Citizens of western

European countries or other more distant countries rarely returned to Hungary as circular migrants. The exceptions to this pattern are German (4.1%) and Chinese people (5.2%). The inclusion of German citizens can be explained by the observation that former Hungarian emigrants and German pensioners moved back and forth between their first and second homes (Illés and Michalkó 2011). The role of Chinese international circular migrants was explained by the emerging Chinese diaspora and was mainly linked to the attraction of the capital, Budapest (Irimiás 2012). The creative industries are mainly located in the Budapest Metropolitan Region. In 2015, 48.3% of the creative and knowledge-intensive firms were located in the capital and its surroundings (Egedy, Kovács and Szabó 2018; Kozina et al., 2019), with a potentially high share of international circulators. The share of US citizens among circulators was 2.9%. These were mainly amenity-seekers, and work- and healthcare-related circulators, just like multiple Russian and Israeli immigrants (1.8%, 1.1%). Both Turkish (1.3%) and Japanese (1.0%) circulators were strongly connected with an economically active life in Hungary (Hárs 2016). Circulators from Turkey were mainly self-employed people in catering and trade. Japanese citizens were employed in multinational companies.

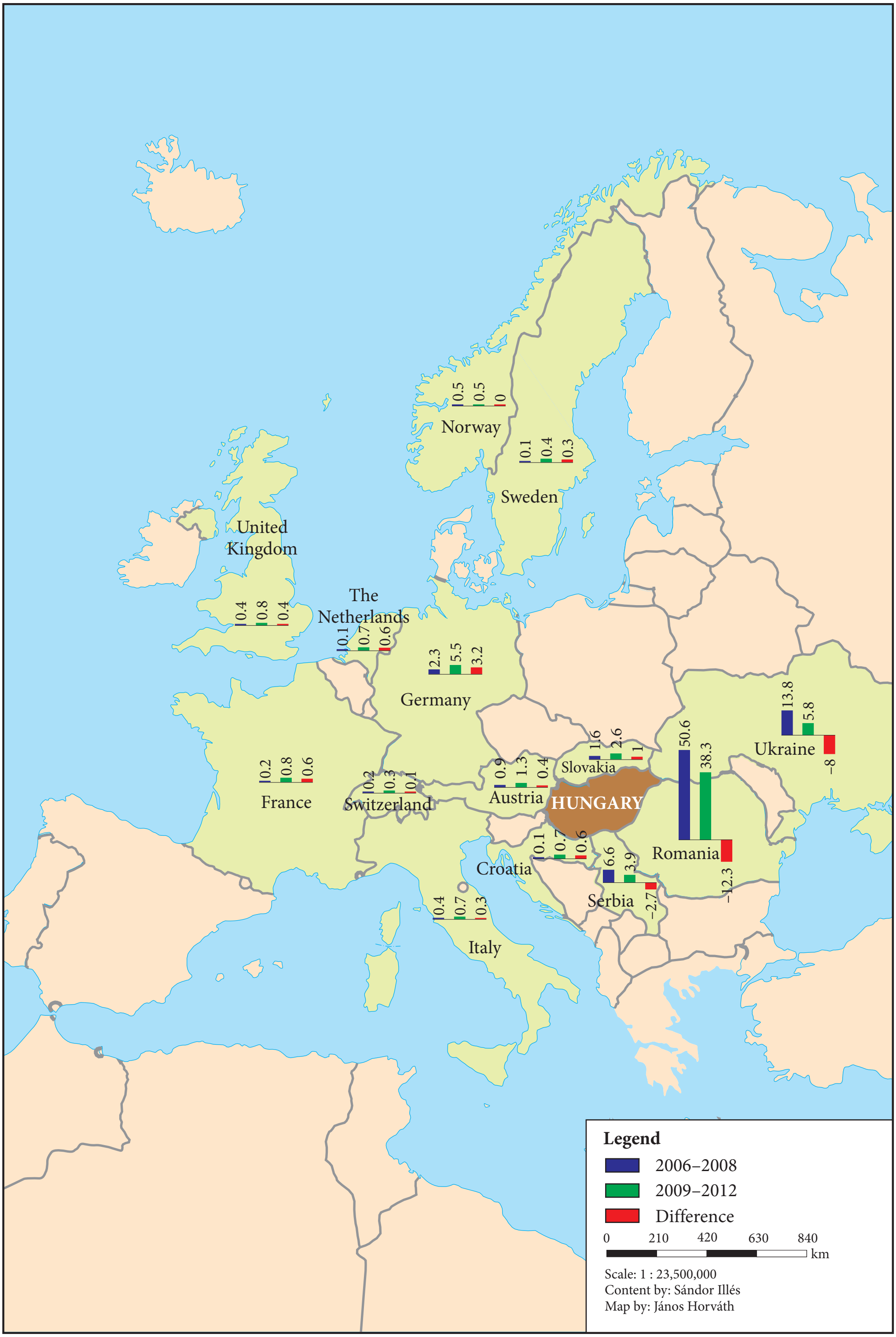
Ethnic Hungarians fluent in Hungarian returned as multiple immigrants from neighboring countries. Their circular migrations functioned as an original solution to the problem of staying in their home country or going to Hungary for work or education. International circular migration, as a repetitive spatial process, has functioned since the 1990s as an effective solution to the situation of Hungarian minorities from neighboring countries channeled by the rapid development of transportation (Dövényi and Tóth 2008; Gellér-Lukács 2011; Tóth, Dávid and Vasa 2014). International circular migration mediates between the migrants' multiple engagements in their home countries and in their destination countries.

Table 2: Distribution of international first-time (1) and circular (2–4) immigrants by country of citizenship within each parity of entrance category in Hungary between 2006 and 2012 (%) (Source: Hungarian Central Statistical Office).

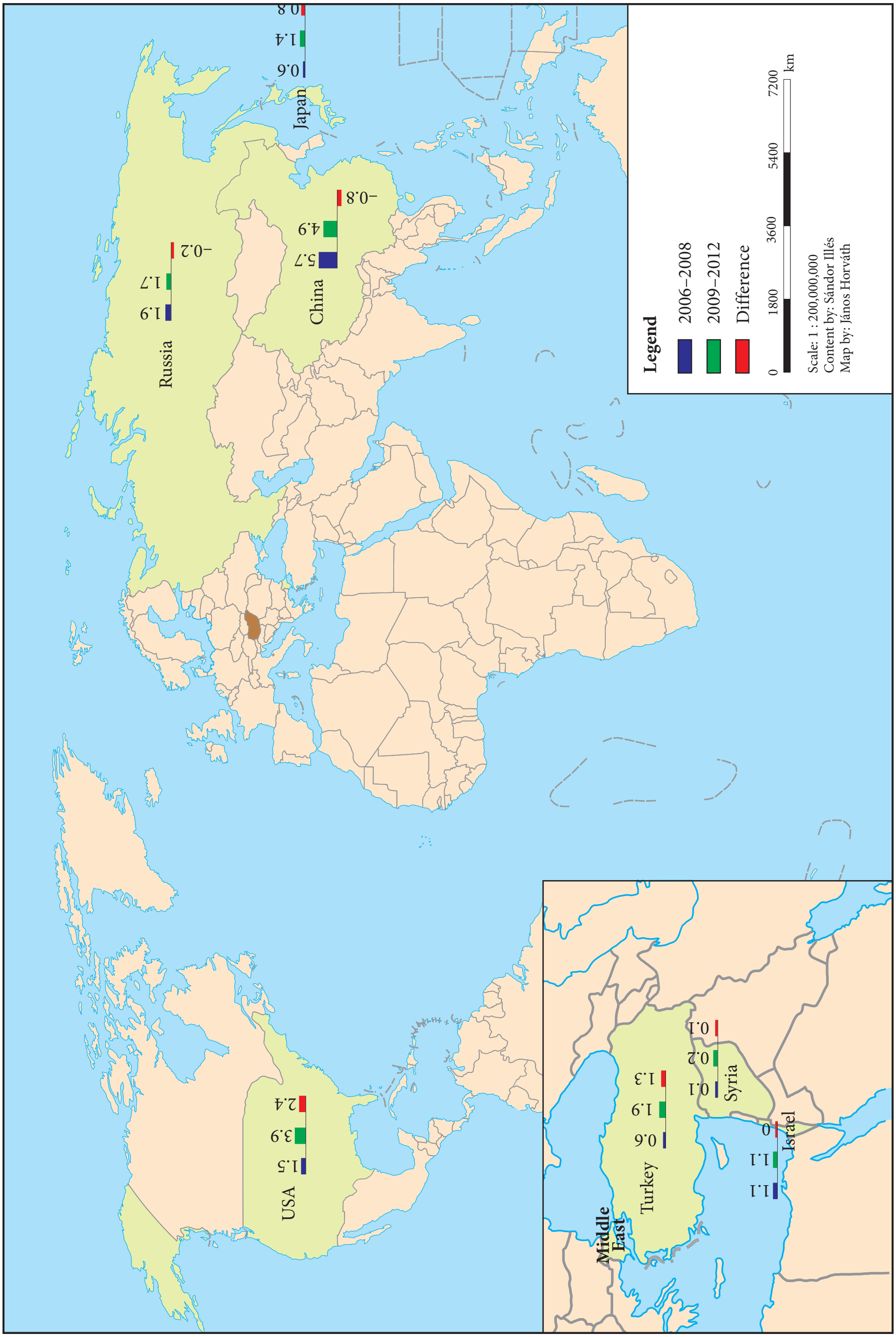
Citizenship	Number of entries					Total
	1	2	3	4	Together (2–4)	
Romania	25.0	58.8	29.5	4.7	43.6	27.8
Serbia	8.3	4.0	6.0	7.9	5.1	7.8
Ukraine	8.8	7.5	12.5	11.6	9.3	8.8
Germany	9.5	2.7	3.6	10.2	4.1	8.7
China	5.6	3.8	6.4	9.0	5.2	5.5
Slovakia	4.7	1.5	2.2	4.8	2.2	4.4
United States	3.9	2.0	3.0	6.0	2.9	3.8
Austria	2.4	0.9	0.8	2.4	1.1	2.2
Turkey	2.1	0.8	1.5	3.2	1.3	2.0
Israel	1.3	0.9	1.2	1.9	1.1	1.3
Japan	1.4	0.7	1.1	2.2	1.0	1.3
Russia	1.6	1.5	2.0	2.7	1.8	1.6
Italy	1.2	0.4	0.4	1.3	0.6	1.1
United Kingdom	1.2	0.4	0.6	1.5	0.6	1.2
Croatia	0.7	0.3	0.4	1.0	0.4	0.7
France	1.1	0.3	0.4	1.5	0.5	1.0
Netherlands	1.1	0.2	0.4	1.4	0.4	1.0
Switzerland	0.5	0.2	0.2	0.5	0.2	0.4
Sweden	0.5	0.1	0.2	0.7	0.2	0.5
Norway	0.5	0.6	0.2	0.6	0.5	0.5
Syria	0.2	0.1	0.2	0.4	0.2	0.2
Other	18.3	12.2	27.3	24.7	17.5	18.2
Total	100.0	100.0	100.0	100.0	100.0	100.0

Figure 2: Spatial distribution of international circular immigrants to Hungary by country of citizenship between 2006 and 2012 (%) from European countries. ➤ p. 28

Figure 3: Spatial distribution of international circular immigrants to Hungary by country of citizenship between 2006 and 2012 (%) from non-European countries. ➤ p. 29



Norway
0.5
0.5
0
Sweden
0.1
0.4
0.3
United Kingdom
0.4
0.8
0.4
The Netherlands
0.1
0.7
0.6
Germany
2.3
5.5
3.2
France
0.2
0.8
0.6
Switzerland
0.2
0.3
0.1
Austria
0.9
1.3
0.4
Slovakia
1.6
2.6
1
HUNGARY
Ukraine
13.8
5.8
−8
Romania
50.6
38.3
−12.3
Croatia
0.1
0.7
0.6
Serbia
6.6
3.9
−2.7
Italy
0.4
0.7
0.3
Legend
2006–2008
2009–2012
Difference
0
210
420
630
840
km
Scale: 1 : 23,500,000
Content by: Sándor Illés
Map by: János Horváth


Legend
2006–2008
2009–2012
Difference
0
1800
3600
5400
7200
km
Scale: 1 : 200,000,000
Content by: Sándor Illés
Map by: János Horváth
Japan
0.6
1.4
0.8
Russia
1.9
1.7
−0.2
China
5.7
4.9
−0.8
USA
1.5
3.9
2.4
Middle East
Turkey
0.6
1.9
1.3
Syria
0.1
0.2
0.1
Israel
1.1
1.1
0

We have shown the pre-crisis and crisis periods separately on maps in European and global contexts. The red columns in Figure 2 reflect the difference between 2009–2012 and 2006–2008. The share of circulators from Romania, Ukraine, Serbia, Russia, and China decreased during the economic recession in Hungary (Figure 2). The share of citizens from the remaining sixteen countries increased under the influence of the downturn. The degree of circularity of individual sending countries to Hungary decreased from Norway, Russia, Ukraine, Romania, and Syria. Citizens from the remaining sixteen countries studied showed an increasing degree of circularity to Hungary during the crises (see Figure 2). Circular migration is most typical for single individuals of productive age from Romania (23.3%), Ukraine (15.6%), and Serbia (9.6%) among the immigrants of each country.

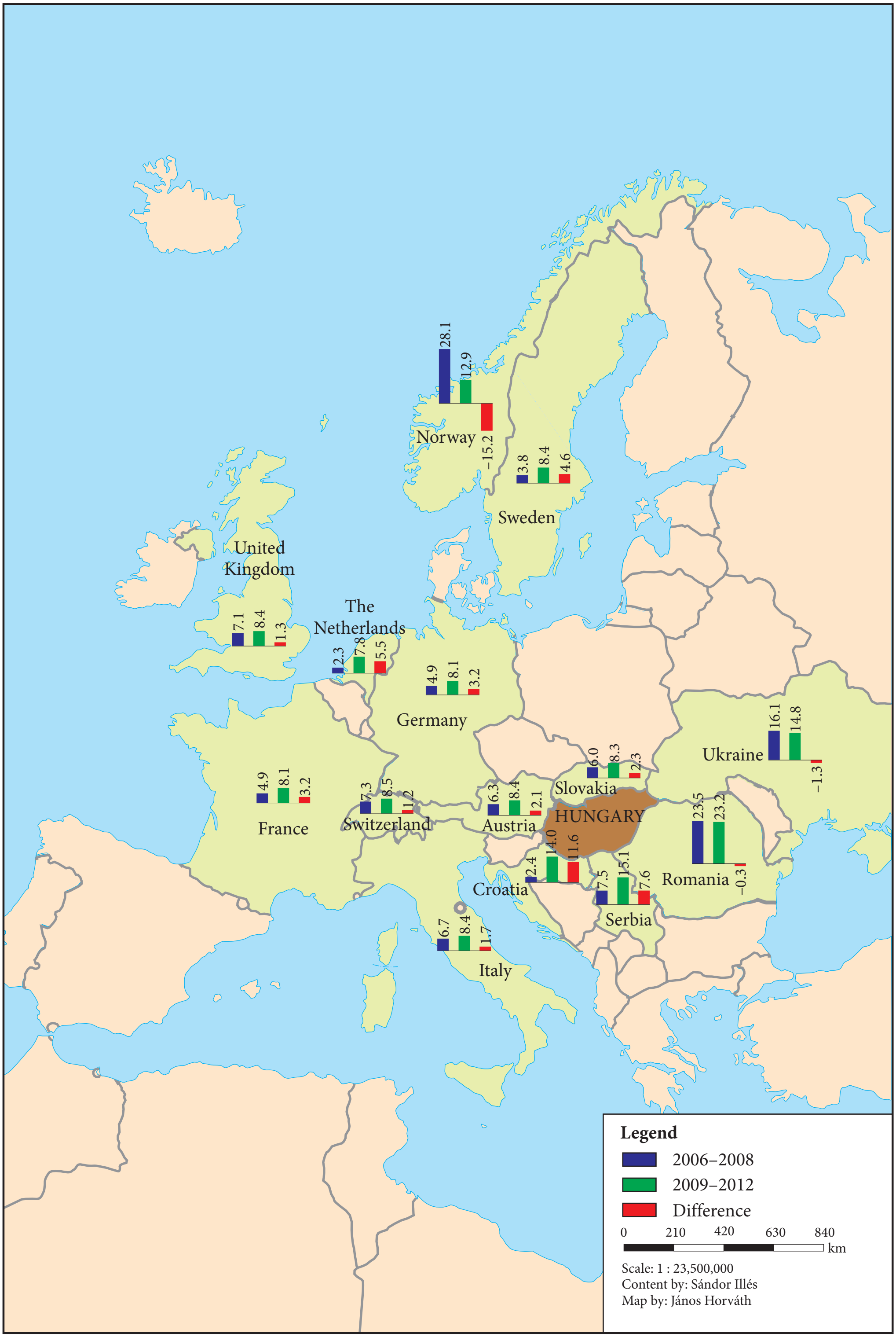
Table 3 shows another aspect of circular immigrants from the perspective of the sending country. Individuals circulate primarily within well-established ethnic Hungarian networks. In addition to the main countries of origin, Norway, Russia, China, Israel, Syria, Japan, the United States, and Turkey represent relatively significant shares of circular immigrants among all immigrants to Hungary. The high proportion of circulators among the immigrants from Norway (16.5%) and Syria (12.0%) are consistent with the mass international immigration of doctoral students to Hungary (Császár and Wusching 2016). However, this scope is outside the short-term Erasmus mobilities of university students to Hungary (Teperics and Czimre 2013; Dabasi-Halász et al. 2018). The relatively significant shares of Russian (16.5%), Israeli (12.6%), and US (11.4%) circulants can be seen in the context of the phenomenon of international pension migration to Hungary. However, economic activity would be the predominant source of international circulators from China (14.1%), Japan (11.5%), and Turkey (10.0%; Galgóczi, Leschke and Watt 2012; Strockmeijer, de Beer and Dagevos 2019).

Table 3: Distribution of international first-time (1) and circular (2–4) immigrants by parity of entrance by country of citizenship in Hungary between 2006 and 2012 (%) (Source: Hungarian Central Statistical Office; authors' calculations).

Citizenship	Number of entries					Total
	1	2	3	4	Together (2–4)	
Romania	76.7	19.5	3.4	0.4	23.3	100.0
Serbia	90.4	4.7	2.5	2.4	9.6	100.0
Ukraine	84.4	7.8	4.6	3.2	15.6	100.0
Germany	93.0	2.8	1.3	2.8	7.0	100.0
China	85.9	6.4	3.7	3.9	14.1	100.0
Slovakia	92.6	3.2	1.6	2.6	7.4	100.0
United States	88.6	5.0	2.6	3.8	11.4	100.0
Austria	92.5	3.8	1.1	2.6	7.5	100.0
Turkey	90.0	3.6	2.5	3.9	10.0	100.0
Israel	87.4	6.1	3.0	3.4	12.6	100.0
Japan	88.5	5.0	2.6	3.9	11.5	100.0
Russia	83.5	8.4	4.0	4.0	16.5	100.0
Italy	92.2	3.8	1.1	2.8	7.8	100.0
United Kingdom	91.9	3.4	1.6	3.1	8.1	100.0
Croatia	90.2	4.2	2.0	3.6	9.8	100.0
France	92.6	2.7	1.2	3.5	7.4	100.0
Netherlands	93.3	2.1	1.2	3.4	6.7	100.0
Switzerland	92.0	3.8	1.3	3.0	8.0	100.0
Sweden	92.7	2.8	1.2	3.3	7.3	100.0
Norway	83.5	11.6	1.5	3.3	16.5	100.0
Syria	88.0	5.0	2.5	4.5	12.0	100.0
Other	85.7	6.2	4.8	3.3	14.3	100.0
Total	85.1	9.2	3.2	2.4	14.9	100.0

Figure 4: Regional distribution of international circular immigrants by country of citizenship in Hungary between 2006 and 2012 (%), from European countries. ➤ p. 31

Figure 5: Regional distribution of international circular immigrants by country of citizenship in Hungary between 2006 and 2012 (%), from non-European countries. ➤ p. 32


Norway
28.1
12.9
–15.2
Sweden
3.8
8.4
4.6
United Kingdom
7.1
8.4
1.3
The Netherlands
2.3
7.8
5.5
Germany
4.9
8.1
3.2
France
4.9
8.1
3.2
Switzerland
7.3
8.5
1.2
Austria
6.3
8.4
2.1
Slovakia
6.0
8.3
2.3
HUNGARY
Ukraine
16.1
14.8
–1.3
Romania
23.5
23.2
–0.3
Croatia
2.4
14.0
11.6
Serbia
7.5
15.1
7.6
Italy
6.7
8.4
1.7
Legend
2006–2008
2009–2012
Difference
0
210
420
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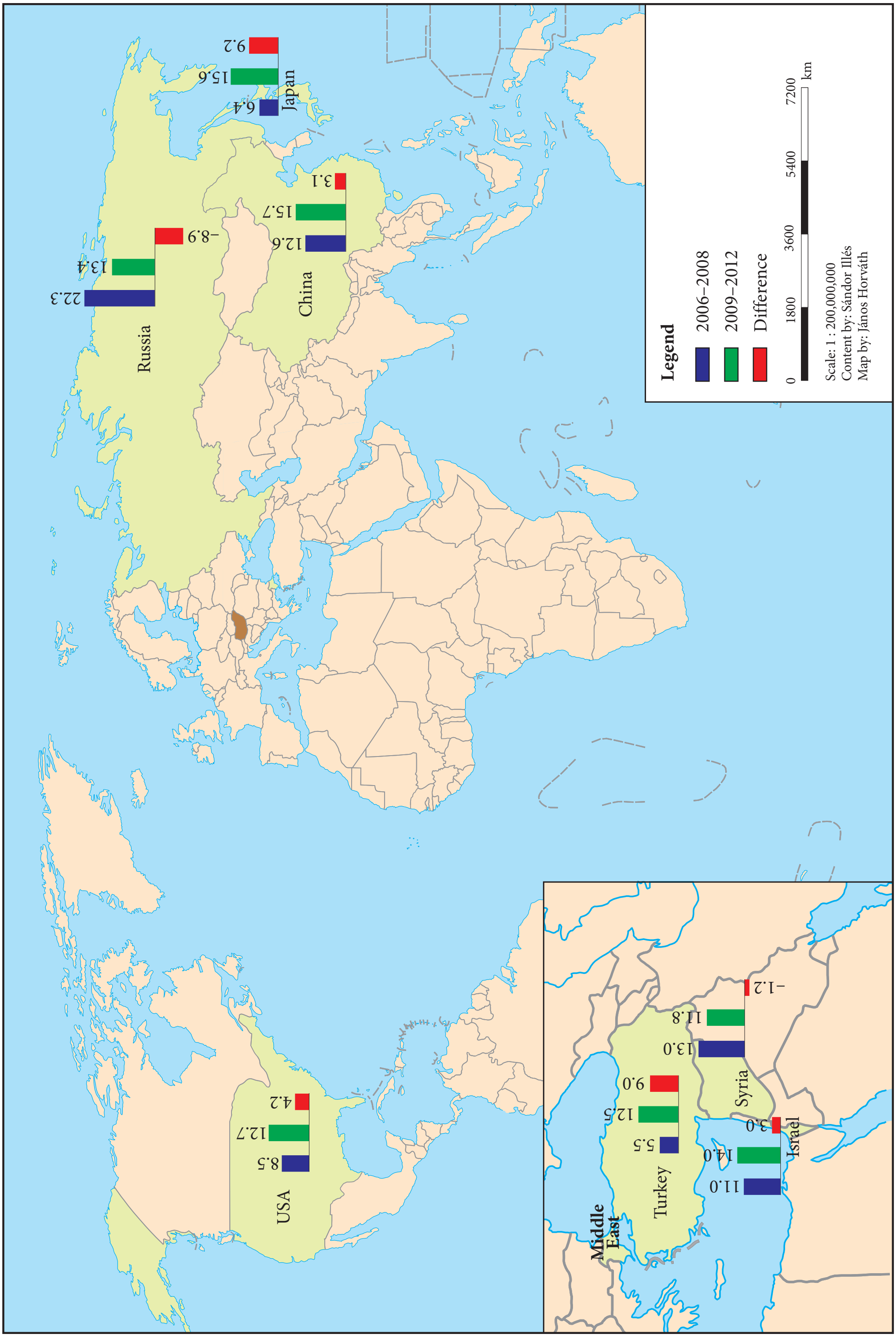
km
Scale: 1 : 23,500,000
Content by: Sándor Illés
Map by: János Horváth



Legend
2006–2008
2009–2012
Difference
0
1800
3600
5400
7200
km
Scale: 1 : 200,000,000
Content by: Sándor Illés
Map by: János Horváth
Japan
6.4
15.6
9.2
China
12.6
15.7
3.1
Russia
22.3
13.4
–8.9
USA
8.5
12.7
4.2
Middle East
Turkey
5.5
12.5
9.0
Israel
11.0
14.0
3.0
Syria
13.0
11.8
–1.2

In further examining the spatiotemporal patterns of each country, we used two different perspectives. First, we analyzed the circulators from the perspective of Hungary as the receiving country (see Table 2 and Figure 2). However, from the perspective of the sending countries – that is, from the perspective of their own citizens – we obtained a different aspect of the analysis (see Table 3 and Figure 3). The meaning of this indicator was the following: the share of circulants in the context of the same national immigrants to Hungary. We can conceptualize this type of indicator as the »degree of circularity.« We visualized the differences between two periods in each country. Based on the directions of change (increase, stagnation, and decrease), some specific groups of countries emerged. According to the increase in frequency of circulators within the entire geographical system from both perspectives, the following subsystems crystallized (Figure 3).

1. Growing levels of circularity during the crisis period: a) All European Economic Area (EEA) countries studied in 2006: Germany, Slovakia, Austria, Italy, the United Kingdom, France, the Netherlands, Switzerland, and Sweden; b) Global expansive economies with an immigration tradition: the United States and Israel; c) Global expansive economies with emigration and no immigration traditions: China and Japan; d) Regional expansive economies with an emigration tradition: Turkey; and e) Potential EEA2006 accession countries with Hungarian minorities: Serbia and Croatia.

2. On the other hand, the shares of circulators decreased among the following citizens of countries, which can be described as countries with decreasing circularity to Hungary: a) Romania with decreasing circularity of immigrants to Hungary (either ethnic Hungarians or other Romanian citizens) due to EEA2006 membership (for both subgroups) and the new Hungarian citizenship law (ethnic Hungarians), but the decrease rate of circulators was higher than the decrease rate of first-entry immigrants; b) Ukraine as a third country from the EU perspective, with decreasing circularity of ethnic Hungarian immigrants to Hungary due to the new Hungarian citizenship law, but the decrease rate of first-entry immigrants was lower than the decrease rate of circulators; c) Russia, with a decreasing share of immigrants to Hungary, but with a decreasing degree of circularity in the crisis period; and d) Norway and Syria with relatively small number of immigrants to Hungary with a decreasing degree of circularity.

5 Discussion

The economic recession resulted in fewer new immigrants arriving in receiving countries (Çağlar 2013; Domínguez-Mujica, Guerra-Talavera and Parreño-Castellano 2014; Roos and Zaun 2016) and more emigrants moving to their home countries or onward (Galgóczi, Leschke and Watt 2012; Baláž and Williams 2018). Between 2006 and 2012, 169,841 foreign immigrants arrived in Hungary according to the Continuous Statistical Register. Of these immigrants, 25,268 had already been staying in Hungary with immigrant status for more than one year. This means that on average of 14.9% of all immigrants were long-term circulators (multiple returnees) that already had personal experience of the country (see Table 1). However, if we distinguish the indicators of the pre-crisis period (14.7%) and the crisis period (15.1%), we conclude that the incidence of circular immigration remained relatively stable under the influence of the decline.

According to Figures 2 and 3 above, the level of circular immigration to Hungary became higher in the years of economic recession among Swedish, Dutch, French, German, American, Turkish, Israeli, Chinese, and Japanese. A moderate increase was observed in the following countries: the United Kingdom, Switzerland, Italy, Austria, Slovakia, Croatia, and Serbia. A narrowing of the gap in indicators took place in Norway, Russia, and Syria. Two quasi-massive exceptions to this general growth pattern could be found in the neighboring countries with Hungarian minorities, where we did not measure the so-called crisis resistance, in combination with the spatial resilience of economic upheaval: Romania and Ukraine. In 2011, the new citizenship law was introduced, which made it easier for ethnic Hungarians living near the border, especially in Romania, Ukraine, Serbia, Croatia, Slovenia, and Austria, to acquire Hungarian citizenship. Due to this new legal regulation, many potential and actual migrants and actual newcomers from these countries became Hungarian citizens. The status upgrade from foreigner to citizen was a rational individual choice among ethnic Hungarians. However, the practice of individual status change reduced the likelihood of becoming international migrants and circulators from a legal perspective in Hungary. Thus, the new Hungarian citizens fell outside the scope of international migration statistics, which, based on the United Nations recommendations (United Nations 1998), covered only foreign nationals. It is likely that the annual proportions of circulators would not have decreased since 2011 if the new citizenship regime had not been introduced by the Hungarian government (Çağlar 2013).

The international circular migrants that came to Hungary from various countries were partly resistant to migrating out of Hungary and they were resilient to returning to Hungary (Michalkó et al. 2014; Zsótér and Kaliczka 2014). Stability in international circular migration processes was strongly correlated with the specific capital and knowledge migrants acquired through their previous immigrations (Kaufmann, Dubois and Ravalet 2018; Illés and Kincses 2018).

6 Conclusion

This article studied a specific population subgroup from the global, regional, and national perspectives: people with immigrant status in Hungary. We separated immigrants into two parts: first-time (»pioneer«) immigrants and multiple immigrants (circulators) during the pre-crisis and crisis periods. A slight increase in circulators was measured (from 14.7% to 15.1%). We concluded that circulators' resilience to the negative consequences of crises was higher than that of pioneer immigrants. In other words, circulators lent a kind of stability to all immigrants. According to the analysis of statistical tables, circulatory immigration flows also remained relatively stable in spatial terms. Exploring stability in the context of circular migration was one of the main innovations of this article.

We mapped the circular systems around Hungary with cartographic representations at the global, regional, and national levels. We pointed out that spatially and temporally stable circular patterns developed around Hungary as a new immigration destination with a short history of immigration flows. We distinguished many subsystems depending on the direction of quantitative changes, according to the nationality of circulators: a) countries with globally expansive economies; b) countries with regionally expansive economies far from Hungary; c) some EEA member states with weak force of geographical distance dependence; d) regionally expansive countries geographically close to Hungary; and e) neighboring countries with ethnic Hungarian minorities and some special countries.

All in all, the change in numbers, indicators, and systems reflected the stable circular patterns in spatially and temporal terms during the economic upheaval. In other words, we found relative stability of circular migration patterns in contrast to the fluidity of pioneer migration patterns.

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Acta geographica Slovenica, 62-1, 2022, 37–53

COMPREHENSIVE LOW-FLOW ANALYSIS OF THE VIPAVA RIVER

Mateja Jelovčan, Mojca Šraj

The Vipava Valley.

DOI: https://doi.org/10.3986/AGS.9399
UDC: 556.16(497.47)
COBISS: 1.01

Mateja Jelovčan[1], Mojca Šraj[2]

Comprehensive low-flow analysis of the Vipava river

ABSTRACT: The article presents the results of the analysis of low flows at 5 gauging stations on the Vipava River, which has a Dinaric pluvial-nival regime (catchment area of 590 km^2). The low-flow statistics show that the gauging station Vipava stands out with the lowest values. Baseflow index (BFI) values are comparable among the considered stations and are around 0.40. Relatively low BFI values indicate low soil permeability. A high similarity between the mean annual minimum 7-day flow (MAM7) and the 95th percentile exceedance discharge (Q95) at all gauging stations indicates a temperate climate. The highest flows values occur in spring and autumn, and the lowest in summer. In wet years there are relatively large fluctuations in flow, while in dry years the flow consists mainly of baseflow. This is also confirmed with the flow duration curves analysis. The seasonality analysis shows a predominant summer regime with low flows.

KEY WORDS: low-flow analysis, lfstat package, Vipava River, Vipava Valley, Slovenia

Analiza nizkih pretokov reke Vipave

V članku so predstavljeni rezultati analize nizkih pretokov na 5 vodomernih postajah na reki Vipavi, ki ima dinarski dežno-snežni režim (površina zaledja 590 km^2). Rezultati statistik nizkih pretokov kažejo, da z najnižjimi vrednostmi izstopa vodomerna postaja Vipava. Vrednosti indeksa baznega odtoka (BFI) so med obravnavanimi postajami primerljive in se gibljejo okoli 0,40. Relativno nizke vrednosti BFI kažejo na nizko prepustnost tal. Velika podobnost med srednjim letnim 7-dnevnim minimalnim pretokom (MAM7) in 95-odstotnim pretokom (Q95) na vseh vodomernih postajah kaže na zmerno podnebje. Največje vrednosti pretokov se pojavijo spomladi in jeseni, najnižje pa poleti. Za mokra leta so značilna relativno velika nihanja pretoka, v sušnih letih pa pretok predstavlja predvsem bazni odtok. To potrjuje tudi analiza krivulj trajanja pretokov. Analiza sezonskosti kaže prevladujoč poletni režim nizkih pretokov.

KLJUČNE BESEDE: analiza nizkih pretokov, paket lfstat, reka Vipava, Vipavska dolina, Slovenija

The article was submitted for publication on December 19th, 2020.
Uredništvo je prejelo prispevek 19. decembra 2020.

[1] University of Ljubljana, Faculty of Natural Sciences and Engeneering, Ljubljana, Slovenia
mateja.jelovcan@geo.ntf.uni-lj.si

[2] University of Ljubljana, Faculty of Civil and Geodetic Engineering, Ljubljana, Slovenia
mojca.sraj@fgg.uni-lj.si (https://orcid.org/0000-0001-7796-5618)

1 Introduction

Low flows usually occur after periods of low precipitation. In addition, low precipitation over a prolonged period of time can lead to hydrological drought. Drought is a complex phenomenon that is difficult to define unambiguously, so there is no single, universally accepted definition of drought. Several types of drought can be defined, differing in both causes and consequences (e.g. Brenčič 2017). Mikoš et al. (2002, 134) define hydrological drought as »Period of abnormally dry weather sufficiently prolonged to give rise to a shortage of water as evidenced by below normal streamflow and lake levels and/or the depletion of soil moisture and a lowering of groundwater levels«.

Comprehensive low-flow analyses are critical for providing information for sustainable water management and planning (WMO 2009). However, flow data can be analysed in several ways using different indicators and methods to describe the low-flow regime of the rivers (e.g. Laaha and Blöschl 2006; Fiala, Ouarda and Hladný 2010; Beck et al. 2013; Petek, Kobold and Šraj 2014; Coch and Mediero, 2016; Sapač, Rusjan and Šraj 2020). To ensure consistent and appropriate analysis of time series of daily flows, the World Meteorological Organization has produced a guidance manual (2009) containing operational information for low-flow prediction and forecasting. In Slovenia, for example, Petek, Kobold and Šraj (2014) analysed low flows at 55 gauging stations of national hydrological monitoring. They found that low flow statistics are very strongly related to the size of the catchment area. The catchment area also affects the values of the recession constant. Sapač, Rusjan and Šraj (2020) analyse various low-flow indices in the hydrogeologically inhomogeneous Ljubljanica river catchment. They found that most of the low-flow indices are consistent with each other and that there are some rivers with specific hydrogeological properties influencing the values of some indices in an inconsistent way compared to other indices. They concluded that in order to correctly interpret the results of low-flow analysis, it is not sufficient to calculate different low-flow indices, but it is necessary to analyse and compare them also with respect to other catchment characteristics.

The main objective of the study is to analyse low flows at five gauging stations on the Vipava River in the Vipava Valley in order to obtain a comprehensive information on the dynamics of the river. The Vipava River has its own characteristics that distinguish it from other watercourses in Slovenia. When we talk about water and watercourses, the analysis of spatial distribution is not enough. We also need to study the temporal changes in the presence of water in watercourses, aquifers and soils, which we can do if we have an appropriate set of data (Brenčič 2013). Comprehensive low-flow analysis includes calculation of low-flow statistics, analysis of hydrographs with baseflow separation, analysis of recession curves and flow duration curves, calculation of baseflow index (BFI) and streamflow deficit, and analysis of seasonality.

2 Methods

2.1 Research area

The Vipava Valley extends in an east-west direction for about 40 km from the headwaters of the Močilnik stream near Razdrto to the Gorica Plain along the Soča River. Its area of 310 km^2 covers a wide strip of Eocene flysch between the high karst plateaus Trnovski Gozd and Nanos in the north and the low plateau Karst in the south. It has an average elevation of 216 m (Kladnik 2013).

The main watercourse in the Vipava Valley is the river Vipava. It originates in numerous springs along the impermeable flysch edge at the foot of the Nanos Mountain. The Vipava River has a Dinaric rain-snow regime with peaks in spring and autumn (Bat et al. 2008). It has the highest flows during snowmelt on the Nanos and partly Hrušica karst plateaus (Uhan and Krajnc 2003). Along its course, the Vipava River receives water from tributaries, that differ in hydromorphology and the amount of water they convey. More important are mainly the streams Hubelj and Lijak (Brenčič 2013). In addition to surface waters, groundwater in intergranular aquifers is also important in the Vipava Valley (Brenčič 2013).

2.2 Data

We analysed daily discharge data series at five gauging stations of the Vipava River (Table 1). Measured discharge data from the gauges Vipava I and Vipava II, Dolenje, Dornberk, Zalošče and Miren and Miren

I gauging stations were applied. The location of gauging stations is shown in Figure 1. The data were obtained from the Surface Water Archive of the Slovenian Environment Agency (http://vode.arso.gov.si/hidarhiv/pov_arhiv_tab.php). A 28-year long data set (1991–2018) was used for the analysis for the Dolenje gauging station, a 64-year data set (1951–2014) for the Dornberk gauging station and a 5-year data set (2014–2018) for the Zalošče gauging station. Due to the short set of data at this gauging station, it cannot be compared with the data at other stations. Therefore, in the chapter 3 Analysis and Results, we only present the results for the Zalošče station, but we do not include them in the discussion. In 2003, during the reconstruction of the bridge over the river Vipava, the Miren gauging station was moved slightly downstream towards the confluence of the Vipava and Soča rivers and the new station was named Miren I. Because the distance between both stations is small, the data set from both stations can be combined into a single set, hereinafter referred to as Miren. A 69-year long data set (1950–2018) was thus used in the analysis for the Miren gauging station. However, in the case of the Vipava and Vipava I gauging stations, the data cannot

Table 1: Main characteristics of the considered gauging stations (Surface Water Archive of the Slovenian Environment Agency).

Gauging station	Station code	Station elevation [m]	Catchment area [km^2]
Vipava	8550	97.4	132
Dolenje	8565	81.4	317
Dornberk	8590	53.9	466
Zalošče	8591	53.9	467
Miren	8600	37.0	590

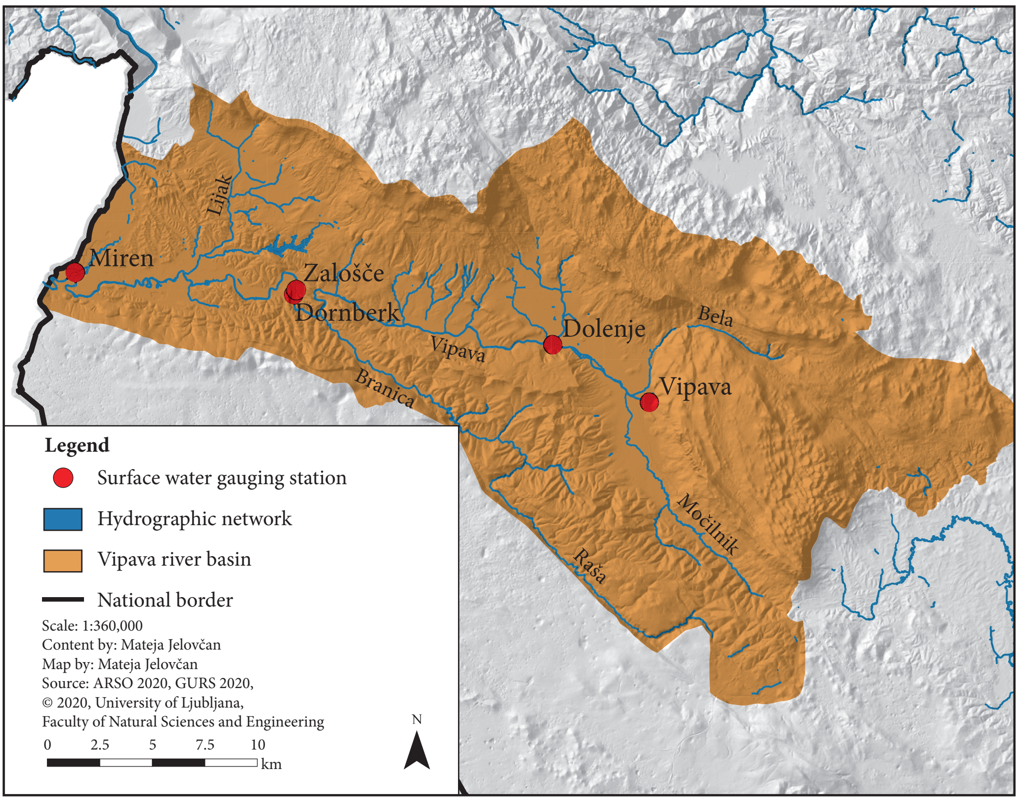

Figure1: Location of the gauging stations of the Vipava River at the Vipava Valley.

be combined. Both stations recorded flows in the area of the springs in Vipava, but the Vipava gauging station turned out to be unreliable, so it was abolished in 1965. As early as 1960, a new station Vipava I was built, which recorded the discharge data from most of the springs of the Vipava River. The Vipava I gauging station was in operation until 2015, when the Vipava II gauging station started operating. A combined set of 59-years of Vipava I and Vipava II gauging stations (1960–2018), hereinafter referred to as Vipava, was used for the analysis.

2.3 Methods

Data analysis and graphical representations were performed using the free and open source R software tool, developed by the R Core Team in 2018 (https://www.R-project.org/). It has been increasingly used for various hydrological analyses in the last decade (e.g., Omuto and Gumbe 2009; Šraj, Bezak and Brilly 2012; Bezak, Horvat and Šraj 2015; Petek, Kobold and Šraj 2014; Sapač, Rusjan and Šraj 2019; Sapač, Rusjan and Šraj 2020). The software allows the extension of existing functions by various packages, thus providing a wide range of different methods for analyses. For the analysis of low-flows, in 2016 Koffler et al. developed the lfstat package (https://cran.r-project.org/web/packages/lfstat/lfstat.pdf) which allows comprehensive analyses of low-flow indices according to the World meteorological organization (2009) recommendations. The analysis of the data in this article includes the calculation of low-flow statistics of the Vipava River, the analysis of hydrographs with baseflow separation, the analysis of recession curves and flow duration curves, the calculation of baseflow index (BFI), the streamflow deficit, and the analysis of seasonality.

The flow duration curve (FDC), allows us to determine the percentage of time that a certain flow value is equal to or greater than the selected value or the relationship between the amount of flow and the frequency of its occurrence (Mikoš et al. 2002). It gives us an overview of the flows in a watercourse and allows us to distinguish between low and high discharge. When analysing low flows, the useful part of the FDC is the one that defines low flows, i.e. flows that are reached in 50% or more of the time. If underground sources contribute substantially to the flow, the FDC in this part will be flat, and in the case of a small contribution from the baseflow, the curve will be steep (Smakhtin 2001). As part of the analysis, we plotted and analysed the FDC for the entire data set and for individual seasons for each gauging station.

Other typical low-flow statistics obtained from the FDC are Q70, Q90, and Q95, which represent a flow exceeded 70%, 90%, and 95% of the time, respectively. In the study, Q50, Q70, Q90, and Q95 were plotted for each gauging station by individual months, and all low-flow statistics were calculated for the entire considered period of each gauging station.

Mean annual minimum n-day flows (MAMn) are also commonly used as low-flow indices and can be calculated for different durations (Tallaksen and Van Lanen 2004; Sapač, Rusjan and Šraj 2019). For example, the mean annual minimum MAM7 represents the average of the minima of the 7-day series of measured flows. In temperate climates, MAM7 is similar to Q95 (WMO 2009). In the study, MAM1 and MAM7 were calculated for each gauging station considered.

Hydrograph separation methods generally divide total flow into the direct surface runoff (fast component) and the baseflow (lagged component). Baseflow originates from groundwater reserves or delayed water sources and thus accounts for most of the flow during the dry season (WMO 2009). The ratio between the baseflow and the total flow is the so-called baseflow index (BFI) (Gustard et al. 1992). BFI values vary with soil permeability, geology and other water-related storage indicators and range from 0 to 1. For impermeable soils, the BFI is less than 0.2, and as permeability increases, the BFI value also increases (WMO 2009). BFI was calculated for each gauging station in the study area. Furthermore, we also selected dry and wet years, visualised them using hydrographs and compared them with each other.

Streamflow deficit represents the period of time during which the flow in a watercourse is below a certain threshold value that defines drought (WMO 2009). To determine the deficit, the threshold level method should be applied defining drought or periods of low watercourse flows (Hisdal and Tallaksen 2000; Cunja, Kobold and Šraj 2020). The deficit begins when the flow falls below the threshold value and ends when it rises above it (WMO 2009). In the study, the flow Q70 was chosen as the threshold. Due to the shortcomings of the threshold level method, such as when daily discharge data are used, there may be an interdependence between droughts and the occurrence of minor droughts. This can be avoided by using other data classification methods (Petek 2014). In this study, a moving average procedure was used in the study. Several indicators can be determined in the context of streamflow deficit (WMO 2009), such as duration (d), deficit volume (V), intensity or volume to duration ratio (mi), minimum deficit flow (Qmin) and time of the event (t) (Figure 2).

The falling limb of the hydrograph is the so-called recession curve. By analysing recession curves, we can determine the change in flow over time and the relationship between them (e.g. Petek 2014; Sapač, Rusjan and Šraj 2019). There are two groups of methods for recession analysis, namely the master recession curve method (MRC) and the method with calculation of parameters for individual recession segments (IRS). The recession constant C is a value that illustrates the degree of recession/decline. It can be determined by both methods mentioned above. Sapač, Rusjan and Šraj (2019) state that both BFI and recession constant can be used to determine river basins characteristics. Both are indicators of water reserves in the river basin. Higher BFI values indicate a better correlation between surface water and groundwater reserves, which represent a larger part of the flow in the river during low flows and thus a higher value of the recession constant. At low BFI, this relationship is poorer thus so the recession constants are lower. In the study, the recession constant was calculated separately for each gauging station using the MRC and IRS methods (threshold value Q70). Different durations of the segments (seglength) were applied, i.e. for 4, 5, 6 and 7 days.

Seasonality ratio is the ratio between summer and winter flows. When the seasonality ratio values are greater than 1, the winter regime with low flows prevails, and when the values are less than 1, the summer regime prevails. In the study the year was divided accordingly with Sapač, Rusjan and Šraj (2020). April 1st was chosen for the beginning of the summer period and December 1st for the beginning of the winter period. The seasonality index is used to show the seasonal distribution of the occurrence of low flows. We determine the date of occurrence of the annual low flow in the Julian calendar (the first day is January 1st, the 365th day is December 31st) (Burn 1997). The dimensionless measure of data dispersion is the parameter r, which ranges between 0 and 1. High values of the parameter r indicate that most extreme drought events occurred on the calculated mean day of year D. High values of r also indicate little variability in the occurrence of low flows throughout the year. On the other hand, low values of the parameter r indicate high variability in the occurrence of extreme events (Young, Round and Gustard 2000).

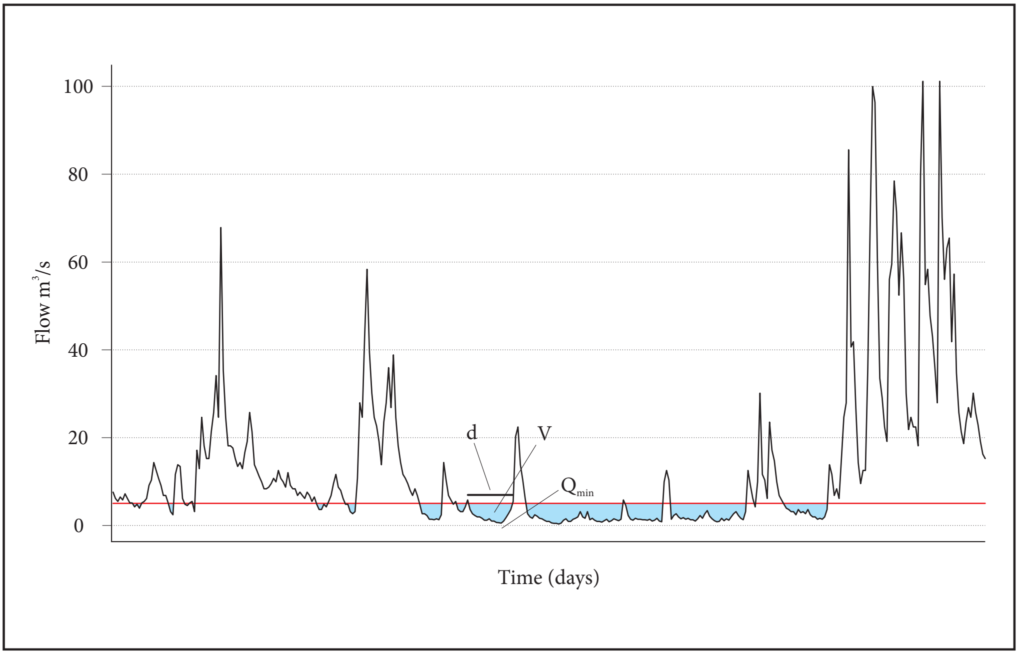

Figure 2: Display of streamflow deficit indicators (WMO 2009); the red line indicates the threshold value.

3 Analysis and Results

3.1 Low-flow statistics, baseflow index (BFI) and hydrographs

The low-flow statistics, i.e. BFI, MAM1, MAM7 and flows from FDCs with exceedances of 50, 70, 90 and 95% of the time for all gauging stations considered are presented in Table 2. The BFI values are comparable between the stations and vary around 0.40, with a slightly lower BFI value observed at the Miren gauging station. Relatively low BFI values indicate low soil permeability at the Vipava Valley. Considering all other low-flow statistics (MAM1, MAM7, Q50, Q95, Q90 and Q70), it is observed that the Vipava gauging station has the lowest values, which then increase along the Vipava River, which is evident from the calculations for the other gauging stations. The lowest value of the mean flow (6.53 m^3/s) belongs to the Vipava station, followed by the Dolenje, Dornberk and Miren stations, where mean flow reaches 17.73 m^3/s. There is also a great similarity between MAM7 and Q95 values at all gauging stations, indicating a temperate climate.

Kobold and Brilly (1994) analysed low flows of various watercourses in Slovenia, including the Vipava River at the Vipava gauging station for the period 1961–1988. The results of our calculations in the case of BFI values show an agreement with their calculation, and minor differences in the results occur in the case of Q50, Q95 and MAM1. Kobold and Brilly (1994) calculated BFI = 0.40, Q50 = 6.94 m^3/s, Q95 = 1.61 m^3/s and MAM1 = 1.26 m^3/s. Cunja, Kobold and Šraj (2019) studied the temporal and spatial analysis of the largest hydrological droughts in Slovenia at selected gauging stations in the period 1960-2016. The results of their MAM7 calculations at the gauging stations Vipava and Miren show slightly lower values compared to our calculations. MAM7 = 0.83 m^3/s was calculated for the Vipava gauging station and 1.21 m^3/s for the Miren gauging station. Petek, Kobold and Šraj (2014) calculated low flow statistics for several gauging stations in Slovenia, including Dornberk. The results of their calculations are comparable to ours. They calculated BFI = 0.38, MAM1 = 1.83 m^3/s, MAM7 = 2.0 m^3/s, Q50 = 14.9 m^3/s, Q70 = 4.6 m^3/s, Q90 = 2.7 m^3/s and Q95 = 2.2 m^3/s.

Figure 3 shows that at the Dornberk gauging station the first maximum low flow occurs in spring (April), and the second, slightly higher maximum low flow occurs in autumn (November). The same is true for

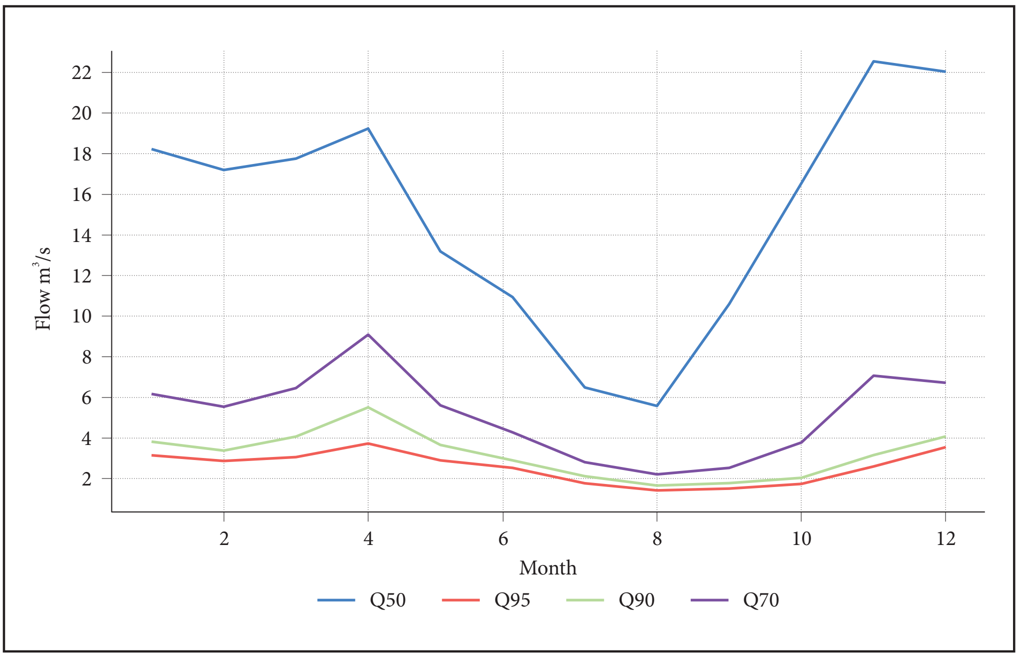

Figure 3: Q50, Q95, Q90 and Q70 by individual months for gauging station Dornberk.

Table 2: Low flow statistics for individual gauging stations in the considered period.

Gauging station	Vipava	Dolenje	Dornberk	Zalošče*	Miren
BFI [/]	0.40	0.40	0.38	0.34	0.35
MAM_1 [m^3/s]	1.17	1.76	1.85	1.77	1.89
MAM_7 [m^3/s]	1.21	1.87	1.99	1.87	2.06
Q_{50} [m^3/s]	6.53	12.19	15.01	15.25	17.73
Q_{70} [m^3/s]	2.20	3.64	4.48	4.12	5.00
Q_{90} [m^3/s]	1.35	2.24	2.46	2.38	2.64
Q_{95} [m^3/s]	1.14	1.91	1.98	2.00	2.08

* Due to the short data set (5 years) at the Zalošče gauging station, the results cannot be directly compared with the results for other stations.

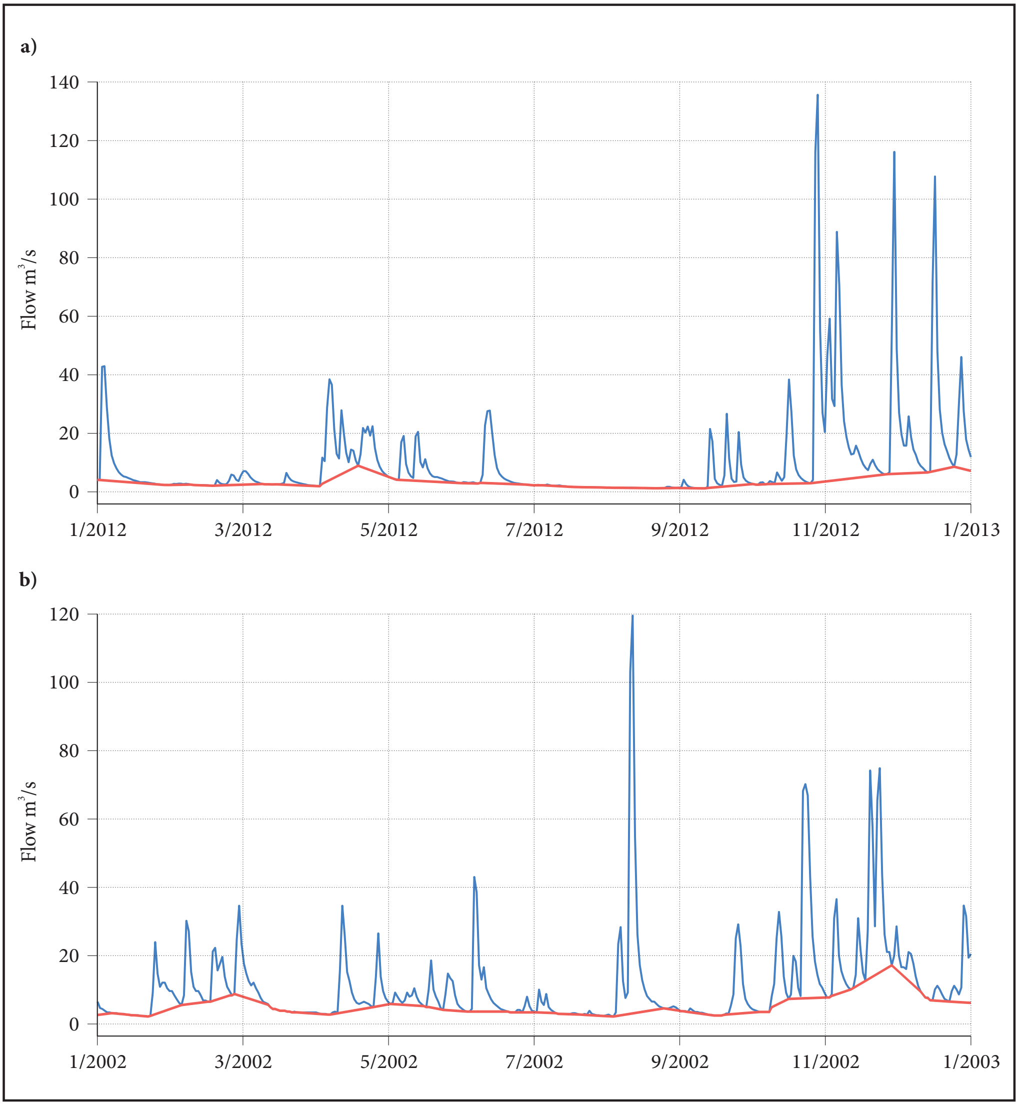

Figure 4: Hydrographs with separated baseflow (red line) for dry year 2012 (A) and wet year 2002 (B) at Dolenje gauging station.

the Vipava, Dolenje and Miren gauging stations. Minimum low flows at these stations are reached during the summer, in July and August. The autumn peak is the result of heavy autumn precipitation, and the spring peak is the result of snowmelt on the high Dinaric plateaus.

The hydrographs for wet years show relatively large fluctuations in flow throughout the year at all gauging stations. For example, Figure 4 shows hydrographs for a dry year (2012) and a wet year (2002) at the Dolenje gauging station. As we can see, the flow during precipitation can increase more than 10 times compared to the baseflow. The large fluctuations in flow are mainly due to the tributaries of the Vipava and the poorly permeable base along which the Vipava River flows. Hydrographs for dry years show higher flows at all gauging stations at the beginning and end of the year, while spring and summer flows consisted mainly of baseflow (red line) (Figure 4A). The drought is most pronounced at the Dolenje gauging station, where flow from mid-January to early April and from late June to mid-September is represented by baseflow (Figure 4A).

3.2 Flow duration curves

Flow duration curves show that in the case of the Vipava gauging station (Figure 5), the flow can increase by a factor 10 or more during extreme events, while at the Dornberk station (Figure 6), as well as the other gauging stations in the Vipava Valley, the flow can increase by a factor of 100 and the flow can reach values up to about 200 m^3/s. The duration curves are quite flat in the part representing the flow below Q50 for all gauging stations, indicating that karst underground sources contribute to the surface flow considerably. Sapač, Rusjan and Šraj (2020) also came to a similar conclusion regarding flow duration curves when analysing low flows in the Ljubljanica river catchment. They found that such shapes of the duration curve, which are also observed in the Vipava Valley, are characteristic of watercourses, whose flow increases greatly after precipitation events, while in non-precipitation periods flows are low and show little fluctuation. This is also confirmed by the large difference in Q90 and Q50 values.

Figures 5B and 6B show the duration curves for the gauging stations Vipava and Dornberk for each season separately, so that the change of flow in the different periods of the year can be observed. In both cases, the curves for spring, autumn and winter overlap more or less, indicating comparable flows in these seasons. However, the duration curve for the summer (red line) lies much lower than the other three, indicating the lowest flows occur in the summer. This curve is flattest in portion representing a flow of less than Q50, indicating that karst underground sources contribute the most to surface flow in the summer.

3.3 Streamflow deficit

The analysis of the streamflow deficit shows that among the identified drought events, the longest drought event lasted 153 days. It occurred at the Dornberk gauging station in 2003 (Figure 7, Table 3), in a year considered as one of the driest in Slovenia since 1960 (Cunja, Kobold and Šraj 2019). The drought event started in early May and lasted until October. It reached a minimum flow of 0.99 m^3/s. The other three

Table 3: Calculated indicators of streamflow deficit for gauging stations Dornberk and Miren.

Gauging station	d (days)	V (m^3)	mi (m^3/day)	Qmin (m^3/s)	Start of the deficit
Dornberk	12	811,963	67,664	3.30	February 18th, 2003
	7	180,045	25,721	4.02	March 20th, 2003
	153	34,396,729	224,815	0.99	May 5th, 2003
	7	1,244,432	177,776	1.72	October 11th, 2003
Miren	3	29,376	9,792	4.81	January 10th, 1950
	3	73,563	24,521	4.70	March 28th, 1950
	1	30,363	30,363	4.65	April 9th, 1950
	9	1,501,755	166,862	1.63	May 9th, 1950
	22	5,000,955	227,316	0.88	May 24th, 1950
	55	16,222,341	294,952	0.58	June 24th, 1950
	30	7,732,923	257,764	1.15	August 23rd, 1950
	16	2,877,861	179,866	1.79	October 9th, 1950

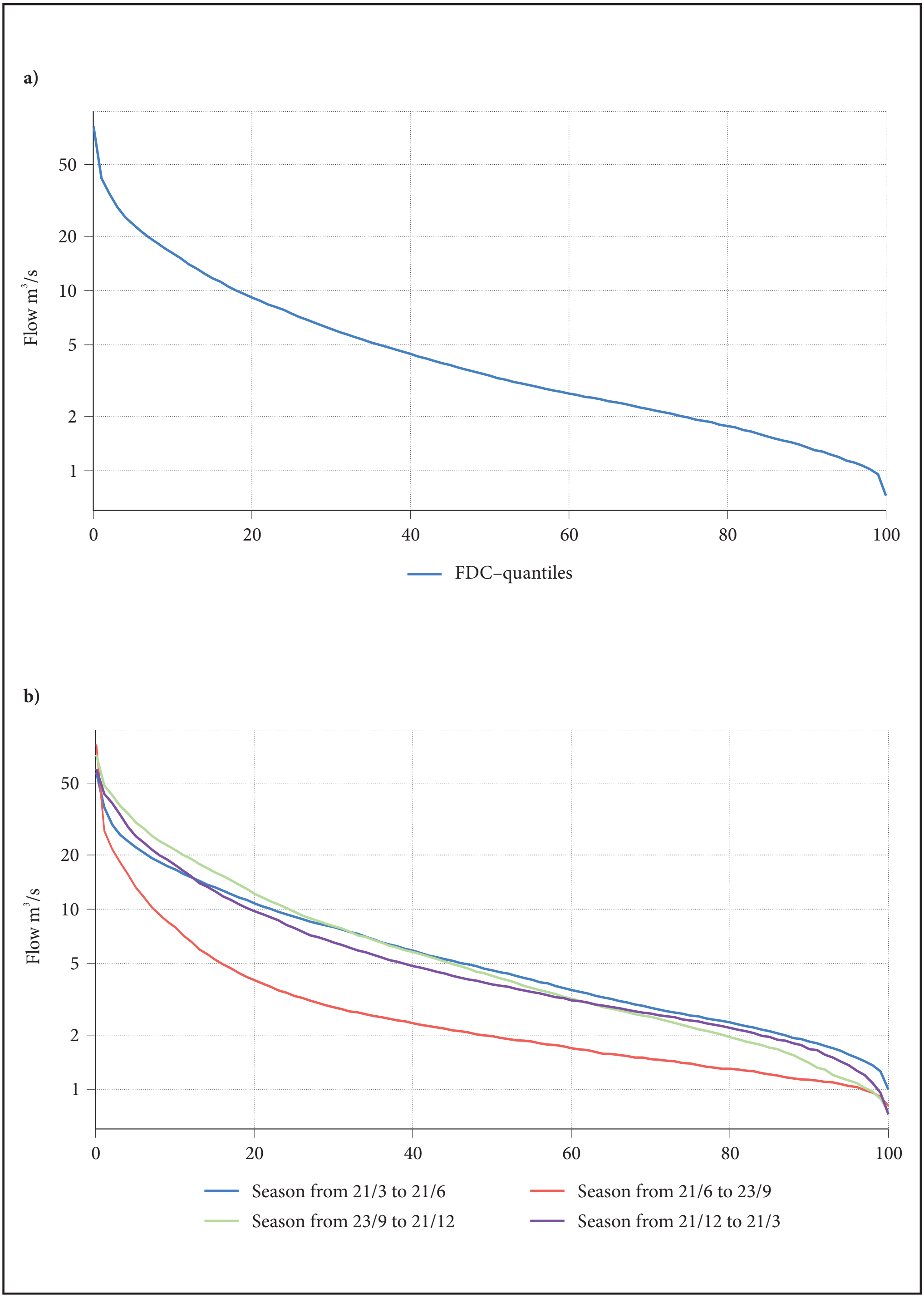

Figure 5: A: Flow duration curve for the whole data set (1960-2018) of the Vipava gauging station. B: Flow duration curves by individual seasons for the Vipava gauging station. The black, red, green, and blue lines represent the spring, summer, autumn, and winter seasons, respectively.

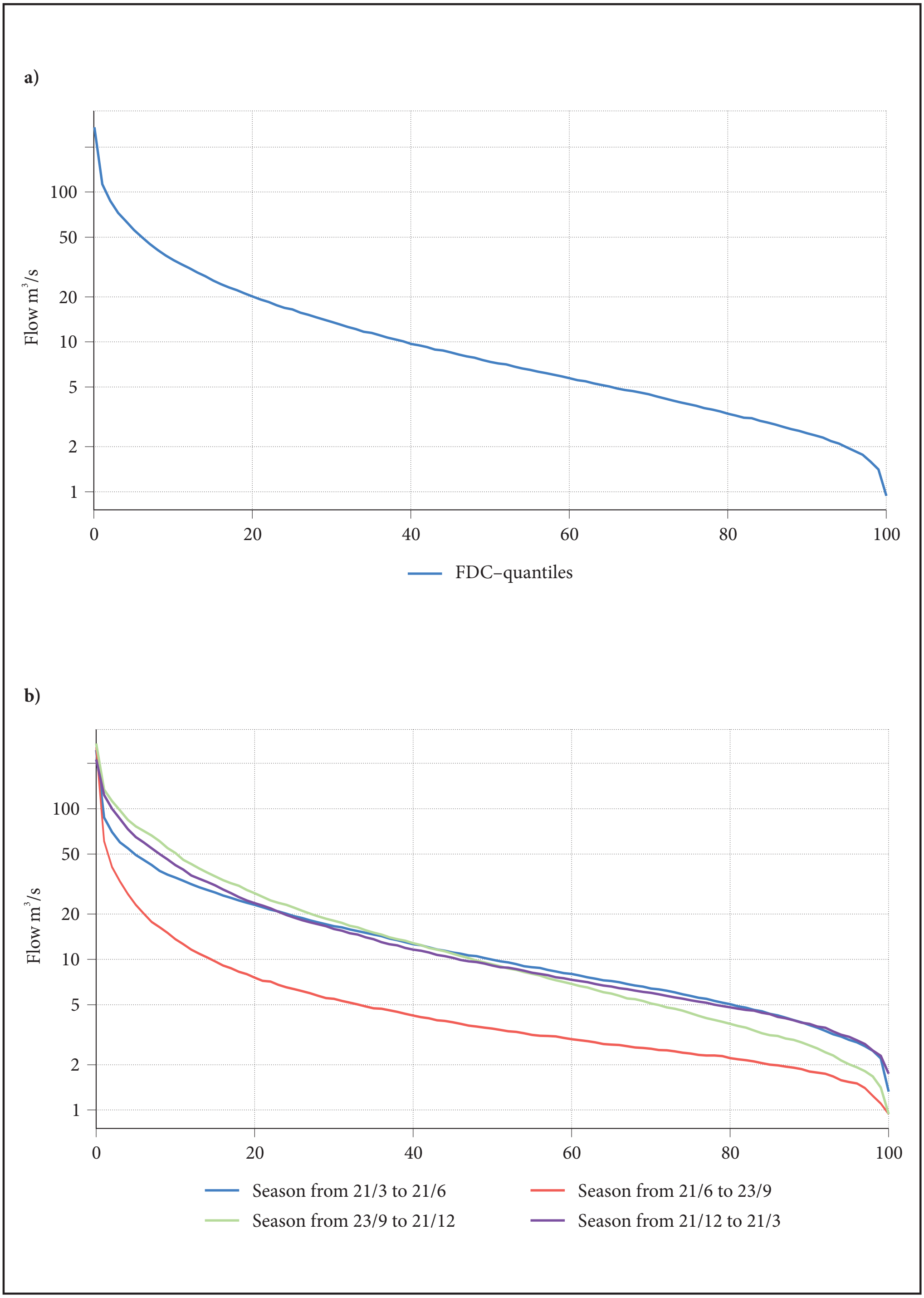

Figure 6: A: Flow duration curve for the whole data set (1951–2014) of the Dornberk gauging station; B: Flow duration curves by individual seasons for the Dornberk gauging station. The black, red, green, and blue lines represent the spring, summer, autumn, and winter seasons, respectively.

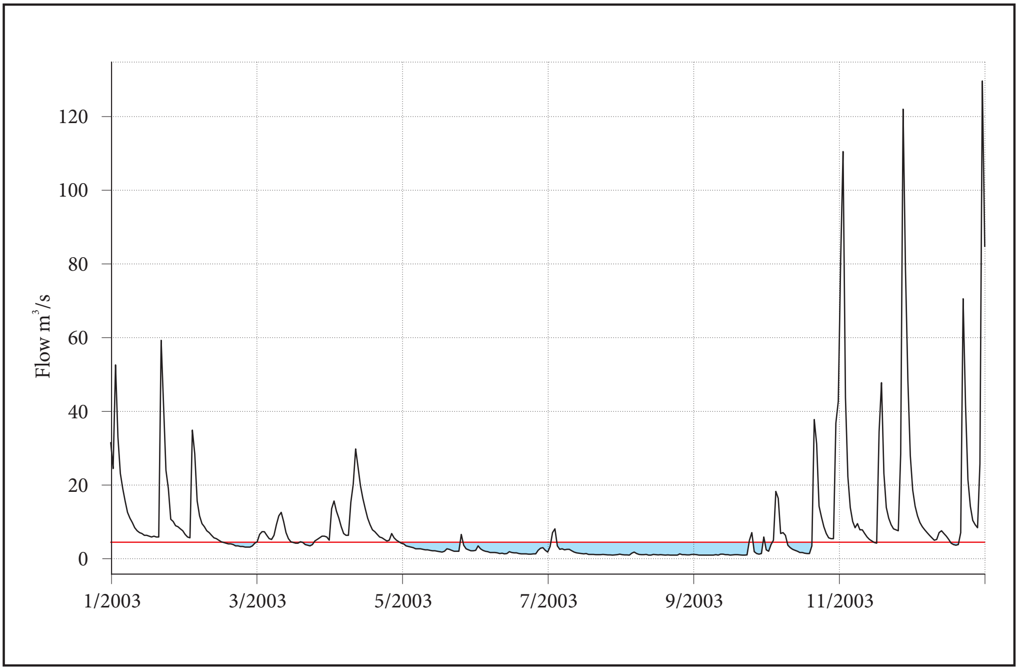

Figure 7: Streamflow deficit for the gauging station Dornberk. The threshold value is marked with the red line and the volume of the streamflow deficit with the blue colour.

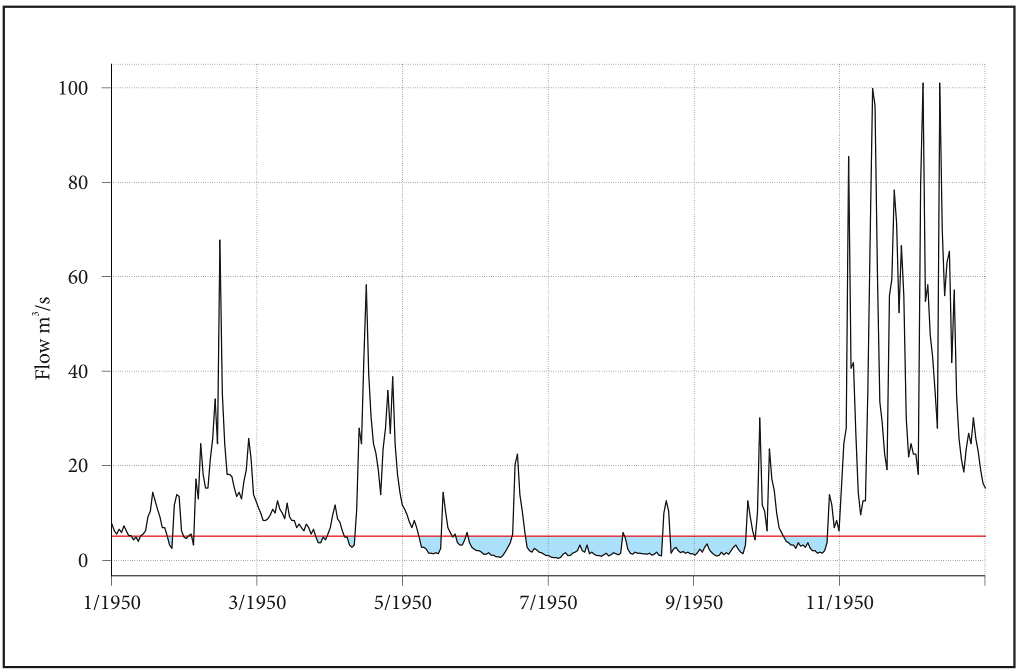

Figure 8: Streamflow deficit for the gauging station Miren. The threshold value is marked with the red line and the volume of the streamflow deficit with the blue colour.

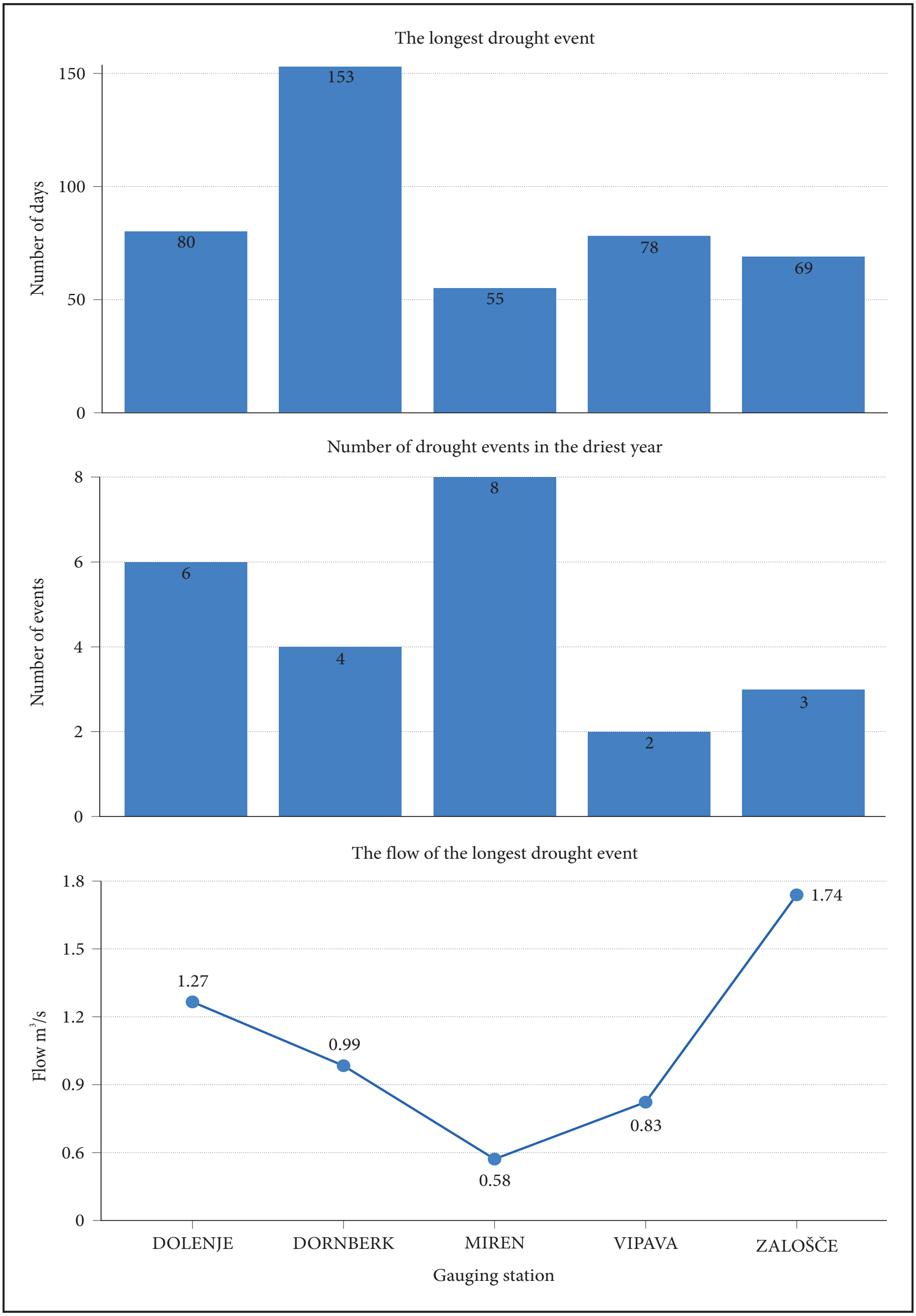

Figure 9: Comparison of the duration and flow of the longest drought events and the number of drought events in the driest year between gauging stations.

drought events in the same year were much shorter, lasting only 7 and 12 days, respectively, and fell in the winter and autumn seasons.

In contrast, the shortest identified drought event was recorded at the Miren gauging station in 1950 (Figure 8, Table 3) and lasted for 55 days. It began in the second half of June (June 24th) and reached a minimum flow of 0.58 m^3/s. This drought event is one of eight drought events that occurred in 1950. The other drought events that year were shorter than 30 days.

Figure 9 shows a comparison of drought events among the individual gauging stations in the Vipava Valley. As described earlier, the longest drought event occurred at the Dornberk gauging station in 2003. The Vipava (78 days in 2004) and Dolenje (80 days in 2012) stations have almost half the length of the longest drought event. The shortest drought event was recorded at the Miren gauging station. The lowest flow measured during drought events was 0.58 m^3/s at the Miren gauging station. At the Miren station, the number of drought events in the driest year 1950 was the highest (8 events). Only two drought events occurred at the Vipava gauging station.

3.4 Recession curve analysis

The recession curve analysis presented in Table 4 shows that the IRS method gives slightly higher values for the recession constants than the MRC method, a fact that was reported by Sapač, Rusjan and Šraj (2019). The Zalošče gauging station has the highest recession constant and the Miren station the lowest. Due to the shortness of the data set (5 years), results of the Zalošče station are difficult to compare with the results of other stations. With high values of recession constants, Zalošče station is followed by the Vipava and Dolenje stations. As mentioned above, stations Vipava and Dolenje had the largest BFI at the same time. Thus, it seems that higher BFI values are associated with higher values of the recession constant, suggesting that surface water and groundwater reserves are well connected. This is consistent with the conclusions of previous studies (e.g. Sapač, Rusjan and Šraj 2019). Furthermore, Jelovčan and Šraj, 2020, analysing groundwater levels in piezometers in the Vipava Valley, reported that piezometers in the lower part of the valley, where the river is in contact with karst, e.g. well-permeable carbonate rocks (limestones), respond less and slower to higher water levels of the Vipava River.

3.5 Seasonality

Seasonality indices for individual gauging stations are presented in Table 5. The calculated values of the seasonality ratio are comparable and range from 0.538 (Miren) to 0.773 (Vipava). Values below 1 indicate that the Vipava River has predominantly low-flow summer regime, which is common in Slovenia, according to Petek, Kobold and Šraj (2014).

The results of the seasonality index show that low flows at all stations occurred in the second half of the year, i.e. in summer. The mean day of occurrence of low flow is at the end of August and it is comparable for the stations Dolenje, Dornberk and Miren. Of the listed stations, only the Vipava station deviates slightly, where the low flow occurs on September 11th. The parameter r is quite large at all stations, indicating that most of the extreme drought events occurred on the calculated mean days, so the variability of the occurrence of low flows throughout the year is low. Petek (2014) also obtained very similar results for both the seasonality ratio and the seasonality index at the Dornberk gauging station.

Table 4: Results of the recession constants in days by the IRS and MRC method (threshold value Q70) for individual gauges in the Vipava Valley.

Seglength	Vipava		Dolenje		Dornberk		Zalošče*		Miren	
	C (IRS)	C (MRC)	C (IRS)	C (MRC)	C (IRS)	C (MRC)	C (IRS)	C (MRC)	C (IRS)	C (MRC)
4	12.59	10.47	11.63	9.22	10.90	9.13	12.61	10.06	10.29	7.97
5	13.14	11.21	12.30	10.05	11.33	9.54	13.91	11.52	10.53	8.72
6	13.60	11.58	13.61	11.15	12.27	10.47	14.94	12.67	11.57	9.50
7	14.72	12.21	14.71	12.31	12.95	10.83	15.32	13.30	13.11	10.80

* Due to the short set of data (5 years) at the Zalošče gauging station, the results cannot be compared directly with the results of other stations.

Table 5: Seasonality ratio and seasonality index for the considered gauging stations.

Gauging station	Seasonality ratio	Seasonality index		
		Θ [rad]	D [/]	r [/]
Vipava	0.773	4.370	254 (11th September)	0.635
Dolenje	0.686	4.109	239 (27th August)	0.875
Dornberk	0.578	4.176	243 (31st August)	0.817
Zalošče*	0.631	4.149	241 (29th August)	0.889
Miren	0.538	4.109	239 (27th August)	0.810

* Due to the short data set (5 years) at the Zalošče gauging station, the results cannot be directly compared with the results of other stations.

4 Discussion

According to Dolinar (2008), the spatial and temporal variability of precipitation in Slovenia is very high. The precipitation regime also changes seasonally. Furthermore, the simulations for the future precipitation in Slovenia predict a significant decrease in summer and its increase in winter by the middle of the 21st century (Slovenian Environment Agency 2019). According to the National water management plan 2016–2021 (Ministrstvo za okolje … 2016) will also have a significant impact on river flows. The same is true for the Vipava Valley, where the autumn season is characterised by an increase in precipitation and other seasons by a decrease (Kajfež Bogataj 2013). Due to the changes in the precipitation regime, low flows and the associated drought and water scarcity can become a major problem in the coming decades (Oblak, Kobold and Šraj 2021). This fact is also supported by the finding that the frequency and intensity of extreme drought events is increasing (Slovenian Environment Agency 2017; Šebenik, Brilly and Šraj 2017). Therefore, a comprehensive analysis of low flows is very important for efficient water management and planning. The analysis of low flows using various indicators, which is presented in this article, is necessary from the point of view of regulation and conservation of water quantities (e.g. Ferk et al. 2020). It is important for sustainable and efficient use of water or, during the minimum available quantities, for anticipating restrictions on the water use in different sectors, for example, agriculture (for irrigation), industry or energy production.

5 Conclusion

In the study, we presented the results of comprehensive analyses of low flows in the Vipava River Valley based on daily discharge data at the Vipava, Dolenje, Dornberk, Zalošče and Miren gauging stations for the available measurement series. Due to the short data set of the Zalošče gauging station, we cannot compare it with the other stations. Therefore, the Zalošče gauging station is included in the study only to achieve greater comprehensiveness of data presentation even though it is not considered in the analyses.

Low-flow statistics analysis shows that maximum low flows occur in spring (April) and autumn (November). Minimum low flows occur in July and August. Relatively low BFI values indicate low soil permeability in the Vipava Valley. The similarity between MAM7 and Q95 values indicates that the study area is characterised by a temperate climate as expected.

The hydrographs for wet years show relatively large fluctuations in flow during the year at all gauging stations, when the flow can increase by more than 10 times relative to the baseflow during precipitation. The hydrographs for dry years show that periods of higher flows occur at the beginning and end of the year, while in the intermediate period, when there is no precipitation, the flow consists mainly of the baseflow.

From the analysis of the flow duration curves we can conclude that the flow is about 2 m^3/s most of the time and can increase 10 times or more during the extreme events. This result is consistent with the shape of the curves, from which we can see that karst underground sources contribute substantially to the surface flow, especially during summer.

The analysis of the streamflow deficit shows that the longest drought event was registered at the Dornberk gauging station in 2003 and lasted 153 days. The highest number of drought events (8 events) in the driest year was recorded at Miren station in 1950.The analysis of recession curves shows that the stations Vipava and Dolenje have high recession constants and Miren station the lowest. We also find that higher BFI values are associated with higher recession constants, indicating a good connection between surface water and groundwater.

The seasonality indices show that low flows occur mainly in summer. The calculated values of seasonality ratios are less than 1 at all gauging stations, indicating that the Vipava River experiences a predominant summer regime of low flows. The mean day of the low flow occurrence is at the end of August.

The study presents in one place the analysis of low flows for all gauging stations on the Vipava River and as such can form the basis for further analysis and research. A comprehensive analysis of low flows at all gauging stations on the Vipava River and their mutual comparison has not yet been carried out. Existing studies and research on low flows on the Vipava River include only single gauging stations and only individual calculations.

Analysis of low flows can be performed for any location, but it is important and necessary especially in areas where the amount of water is limited. In general, the comprehensive analysis of low flows is necessary in terms of sustainable water management and planning.

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Acta geographica Slovenica, 62-1, 2022, 55–64

TEACHING AND LEARNING LANDSCAPE IN PRIMARY EDUCATION IN SPAIN: A NECESSARY CURRICULAR REVIEW TO EDUCATE CITIZENS

Francisco Xosé Armas-Quintá, Francisco Rodríguez-Lestegás,
Xosé Carlos Macía-Arce, Yamilé Pérez-Guilarte

Small village in the geographical centre of Galicia (Spain).

DOI: https://doi.org/10.3986/AGS.10457
UDC: 373.3.016:911.5(460)
COBISS: 1.01

Francisco Xosé Armas-Quintá[1], Francisco Rodríguez-Lestegás[1], Xosé Carlos Macía-Arce[1], Yamilé Pérez-Guilarte[2]

Teaching and learning landscape in primary education in Spain: A necessary curricular review to educate citizens

ABSTRACT: The study of landscape is not new, nor is society's concern for the environment. It occupies a central place in teaching geography and offers many opportunities for the integration of one's own contents of geographic education. Landscape must be presented as a portion of space on the Earth's surface where natural elements and the actions of human beings interact, a complex reality where nature and culture mix. Knowing a landscape means more than knowing a portion of the territory, it also implies understanding the social groups and peoples that inhabit it. In this regard, and in addition to the study of exceptional, singular, or exotic landscapes, it is necessary to value the importance of ordinary landscapes close to schoolchildren. In this article, a curricular review of primary education in Galicia (Spain) is carried out with the aim of knowing how the study of landscape is approached, also taking into account the guidelines set out in the basic curricula at the national level.

KEY WORDS: geography, landscape, curricula, didactics, environment, Galicia, Spain

Pokrajina poučevanja in učenja v osnovnem šolstvu v Španiji: Potreben pregled kurikuluma za izobraževanje državljanov

POVZETEK: Preučevanje pokrajine ni novo, prav tako ne skrb družbe za okolje, ki zavzema osrednje mesto v pouku geografije in ponuja številne možnosti za integracijo lastnih vsebin geografskega izobraževanja. Pokrajino je treba predstaviti kot del zemeljskega površja, kjer se prepletajo naravni elementi in dejanja ljudi. Je kompleksna realnost, kjer se mešata narava in kultura. Poznavanje pokrajine pomeni več kot poznavanje dela ozemlja, pomeni tudi razumevanje družbenih skupin in ljudstev, ki jo naseljujejo. V zvezi s tem in poleg preučevanja izjemnih, edinstvenih ali eksotičnih pokrajin je treba ceniti pomen običajnih pokrajin, ki so blizu šolarjem. Članek predstavlja kurikularni pregled osnovnošolskega izobraževanja v Galiciji (Španija) z namenom spoznati pristope k študiju pokrajine, ob upoštevanju smernic, določenih v temeljnih učnih načrtih na nacionalni ravni.

KLJUČNE BESEDE: geografija, pokrajina, učni načrti, didaktika, okolje, Galicija, Španija

The article was submitted for publication on October 13th, 2021.
Uredništvo je prejelo prispevek 13. oktobra 2021.

[1] University of Santiago de Compostela, Santiago de Compostela, Spain
francisco.armas@usc.es (https://orcid.org/0000-0002-8644-8185), f.lestegas@usc.es (http://orcid.org/0000-0002-1733-3085), carlos.macia@usc.es (https://orcid.org/0000-0001-8597-4557)

[2] University of A Coruña, A Coruña, Spain
yamile.perez@udc.es (https://orcid.org/0000-0002-2086-3765)

1 Introduction

The study of landscape is not new, nor is society's concern for the environment. This fact has been materialising in the celebrations of the different international conferences on the environment promoted by the UN and UNESCO in which the need to create a common consciousness to preserve our environment through education in all countries has been stressed at all levels.

Numerous works from different disciplines have been devoted to the conceptual and epistemological analysis of the landscape (Corbera Millán 2016; Cebrián Abellán and García Martínez 2016; Rubio Tenor and Ojeda Rivera 2018), especially those of a territorial nature such as Geography (Serrano Giné 2013), which meant an enrichment of the term (Luque Revuelto 2012). The landscape is no longer seen and treated as a combination of sciences, but is placed above them to evolve towards a universal way of observing the environment (Vallina Rodríguez 2020).

Furthermore, at present, we are witnessing an unusual scientific and technical interest in its study, protection and enhancement (Mulero Mendigorri 2013), especially by geographers (Gómez Ortiz 1993), surpassing the environmental and territorial sphere and permeating, increasingly, towards areas of marked cultural and political character (Serrano Giné 2013). Along with this, this interest comes from a capitalist-oriented strategy of economic valorisation of the territory and decisively promoted by public administrations (Corbera Millán 2016).

The purpose of the European Landscape Convention arose as a result of environmental degradation and the need to conserve the natural and Europe's cultural heritage. This Convention encouraged the different public administrations to adopt policies at different scales in order to protect, plan and manage European landscapes. In the same way, all forms of European landscapes, natural, rural, urban and periurban, both emblematic and ordinary, were recognised, in addition to the need to promote education about the landscape (Council of Europe Landscape Convention 2000). The adoption of the Council of Europe Landscape Convention has been the basis of a shared language and the beginning of overcoming a long period of dialogue of the deaf, disagreements and useless nominalist debates in which the concept of landscape was repeatedly described as polysemic, ambiguous or flimsy (Zoido Naranjo 2012).

The worry for the study of landscape in schools is strengthened with the establishment of the *Escuela Nueva*, where the student is considered as the centre and end of teaching and makes them the protagonist of education. In this regard, it is argued that learning must start from their own experiences, which is why the immediate environment takes on an extraordinary didactic value. If in the first decades of the last century landscape was a pedagogical resource that allowed certain learnings to be tackled, at present it is also an educational objective that aims to contribute to creating a collective consciousness about the need to maintain the different ecosystems that define the Earth's landscapes (Gómez Ortiz 1993).

In Spain, all references to the educational interest of the landscape come from the *Institución Libre de Enseñanza* (Free Institution of Education), which carried out its activities between 1876 and 1939. One of the most prominent promoters of this pedagogical project was Francisco Giner de los Ríos, a distinguished follower of the philosophical krausista movement. From this system of thought, the educational principles of the *Institución Libre de Enseñanza* are specified in encyclopedic teaching, comprehensive education (intellectual, aesthetic and moral), active teaching, the intuitive method, the *Lessons of things* (Type of textbooks dedicated to teaching, especially regulated ones, which were composed of texts on various topics whose main purpose was reading, writing and, on rare occasions, calculus.) and, in a singular way, hiking excursions. These are the procedures that will allow children to approach directly to nature that surrounds them and the real world, developing the capacities of observation, investigation, personal initiative and sociability (Melcón Beltrán 1995).

Teaching geography through the landscape is part of a didactic trend with a long tradition in our country, especially in primary education. Today this tradition is revising its concept and orientation as the idea of landscape deepens, introducing a new vision of landscape education into the school curriculum. This aims to be a tool for the intellectual and personal growth of students in a framework in which formal and informal education meet to respond to the challenges of the 21st century (Batllori i Obiols and Serra i Sala 2017). Thus, this article presents an exhaustive review of the basic curriculum of primary education, regulated by the Royal Decree 126/2014 (Boletín Oficial del Estado 52, 1. 3. 2014) and the curriculum of primary education in the Autonomous Community of Galicia, regulated by the Decree 105/2014 (Diario Oficial de Galicia 171, 9. 9. 2014) in order to analyse what is proposed in Spain for the teaching and learning of the landscape at all levels of this educational stage.

2 Methods

Understanding how landscape teaching and learning is being carried out in primary education in Spain and Galicia meant, in addition to analysing the basic curriculum of primary education (Royal Decree 126/2014) and the curriculum of primary education in the Autonomous Community of Galicia (Decree 105/2014), reviewing the scientific production related to the study and teaching of the landscape, especially that published in the Spanish journals with the greatest impact on geography, geography didactics and social sciences didactics.

In the case of Geography journals, the ten Spanish journals with the highest impact indexed in the Journal Citation Reports (JCR) and in Scopus were consulted over the last eleven years (2010–2021) using »landscape« as the keyword. In total, more than three hundred issues of the journals have been reviewed: *Boletín de la Asociación de Geógrafos Españoles, Scripta Nova, Anales de Geografía de la Universidad Complutense, Ciudad y Territorio. Estudios territoriales, Cuadernos de Investigación Geográfica, Cuadernos Geográficos, Documents d'Anàlisi Geográfica, Estudios Geográficos, Investigaciones Geográficas,* and *Investigaciones Regionales*. In the same way, the most outstanding journals of geography didactics and social sciences didactics in Spain have also been reviewed, including *Didáctica Geográfica, Revista de Investigación en Didáctica de las Ciencias Sociales, Íber. Didáctica de las Ciencias Sociales, Geografía e Historia,* and *Didáctica de las Ciencias Experimentales y Sociales.*

In relation to the revision of the basic curriculum of primary education (Royal Decree 126/2014) and the curriculum of primary education in the Autonomous Community of Galicia (Decree 105/2014), the contents of the thematic blocks »Common contents«, »The world that surrounds us« and »Living in society« are analysed, with special attention paid to the second block because it contains all the topics related with the landscape.

3 Literature review

At present, the landscape is present in a good part of the dimensions that make up human life and this implies analysing, explaining and understanding it from different perspectives, which contributes to consolidating its complexity (Rubio Tenor and Ojeda Rivera 2018). The concept of landscape has been the object of multiple approaches and meanings with a multifaceted vision that encompasses both purely morphological postulates and aesthetic, symbolic and spiritual visions (Silva 2009). In addition, the concept of landscape has great possibilities for the convergence of different approaches, as well as its usefulness when tackling the difficult and complex task of territorial governance (Zoido Naranjo 2012). It is also important, when defining the landscape, to take into account certain insights that are typically of it, such as its evolutionary trend and its dynamism (Pérez Alberti 2008; Fernández Álvarez 2013).

Landscape is the result of people's relationship with their perceived, daily or visited environment, an element of territorial identity (Mata Olmo 2008), and the greatest exponent of the natural and cultural evolution of a territory (Martínez de Pisón 2000). Every landscape, whether material or imaginary, is a representation of reality, a social and intellectual construction and a cultural product (Mateu i Lladó 2014; Corbera Millán 2016) that can vary from one culture to another and, also, from one era to another (Maderuelo 2010). The views on the landscapes are diverse but all of them are essential to understand the relationships between the human being and the territory. Not only the places matter but also the collective feelings and certain forms of life that have their projection in the landscapes (Benito del Pozo 2012).

The most common source for subjective knowledge of the landscape is the mental construction, like a sketch, that an individual makes regarding the shape of the territory (Venegas-Moreno et al. 2021). The perception of the landscape is shaped by representations linked to the observer's cultural environment, by experiences, memories and individual intentions, as well as by material spaces. In this way, one part of perception has a subjective component and another has a notable sociocultural background (Cosgrove 2002).

The consideration of landscape as an element of quality of life and identity of places, as heritage and resource for sustainable territorial development has emerged strongly in recent times (Mata and Ferrer 2021). Different authors have insisted on explaining the recovery of interest in the landscape as a kind of awareness of the deterioration that it has been suffering as a consequence of the industrialisation and urbanisation processes (Corbera Millán 2016). Lately, there has been a serious landscape impoverishment and a good part of the essence of our landscapes has deteriorated. Diffuse urbanisation, disorganised urban growth and detachment from traditional urban settlements, has destroyed the territorial logic of much of the country. The causes that have given rise to this situation are varied, but the lack of awareness of the landscape and of a sensitivity towards this exceptional heritage asset that is the landscape can be highlighted (Nogué 2010).

Landscape must be presented as an experiential space in which the human being not only lives and develops, but, due to their ability to transform it, has the obligation to watch over it, harmonising its exploitation and preservation (Gómez Ortiz 1993). Landscape is also an experience, a way of seeing and imagining the world producing feelings and aesthetic and ethical evaluations. Landscape only opens the eyes of those who know how to interpret it (Liceras 2013). It is a complete intellectual exercise where, in addition to the necessary rigor and intelligence, sensitivity and direct experience are particularly appropriate (Martínez de Pisón 2010).

3.1 Some considerations for landscape education

The concept of landscape has a prominent presence in the curriculum of primary education social sciences, and among its educational proposals, the landscape as a social and cultural construction and the large landscape units are part (Batllori i Obiols and Serra i Sala 2017). Work is being carried out, especially in geography, so that the study of the landscape does not refer only to the elements that compose it, but rather deepens the relationships that arise between the elements that it is comprised of (Fernández and Plaza Gutiérrez 2019).

Landscape and environment have always been present in schools (Gómez Ortiz 1993; Busquets 2010) and it has been an educational resource which has played an important role in pedagogical renewal movements by means of promoting field work and its relationship with the environment (Busquets 2010). Landscape currently occupies a very important place in very diverse fields of knowledge (Liceras 2013) and has developed according to the progress and diversity of the approaches taken, but its presence in schools has stood out, especially, in the subjects of Geography and Natural Sciences (Gómez Ortiz 1993; Busquets 2010).

The study of landscape can be approached at any level of education, from the initial stages of the training of individuals, due to its conceptual richness and interdisciplinarity character, as well as adapting its didactic methodology to the progressive development of the cognitive capacities of the students (Liceras 2013). Despite this, it is necessary to bear in mind that landscape education should not be associated with a break with disciplinary approaches towards the knowledge of landscape but must incorporate perceptual and social dimensions into these approaches (Busquets 2010).

Landscape studies in schools must be conceived from a double perspective; on the one hand, instructing students in certain curricular areas and a deeper understanding of specific contents and, on the other, educating them towards the cultivation of a reflective and critical spirit (Gómez Ortiz 1993). Landscape has, in education, a notorious tradition associated, mainly, with the teaching of geography and history. This teaching background is the basis of knowledge and appreciation of landscape by the youngest, although it should be updated in terms of its heritage, social and global dimensions, as well as the values that it transmits (Prats and Busquets 2010).

The study of landscape occupies a central place in the didactics of geography, while offering numerous opportunities for the integration of content typical of geographic education, ranging from the development of spatial thinking and cartographic literacy to commitment and participation of citizenship (García de la Vega 2019). It is logical, then, that the landscape is a common object of study in all educational systems and that it has played an important role in the activities developed by the pedagogical renewal movements, which promoted preferential attention toward the environment and field work (Busquets 2010; Feliu and Hernández 2015).

Landscape education requires the use of multiple resources from the environment itself, with activities outside the school that must also have continuity within the classroom. In this sense, the instruments traditionally used to perceive landscapes were closely associated with direct observation and the use of conventional photographs, sketches and cartographic documents. However, nowadays the impact of new technologies, digital cartography, Geographic Information Systems (GIS) and, especially, Web GIS cannot be ignored as resources for landscape education. Through GIS, students can select and combine different layers of geographic information, which will help them understand the complex interplay of physical and human factors in shaping landscapes, as well as develop critical and creative thinking. In addition to GIS and Web GIS, there are other applications and digital tools, such as those developed by Google (Google Earth, Google Maps, Google Street View), which are changing the methods and procedures for learning about landscape in the classrooms (De Miguel González 2016).

Educating people about landscape does not mean dispensing with the various disciplinary approaches toward the knowledge of landscape, but rather incorporating the perceptual and social dimensions into these contributions (Busquets 2010).

4 Landscape in the curriculum of primary education in Galicia

The inclusion of landscape in the curricula of primary education has been a notable success, and this interest in the study of landscape has been in force in teaching practice over the years (Gómez Ortiz 1993). In Spain, the didactics of geography has consolidated the study of the landscape from different disciplinary and didactic perspectives. Although the curriculum is the normative reference in education, the treatment of the landscape in schools should be completed with methodological strategies and specific didactic resources, which would also imply resorting to other documents, regulations and educational research (García de la Vega 2019).

The Galician Primary Education curriculum (Decree 105/2014) aims to contribute to the personal and social development of students, as well as their integration and participation in the society in which they live. As stated in the curriculum, the area of social sciences integrates various fields of study among which are geographic, sociological, economic and historical aspects, although, in reality, the contents will barely cover the objective of contributing to the personal and social development of the student. The review of the contents for the social sciences revealed a scarce presence of human geography, which is a great weakness when it comes to understanding the different social, economic and cultural processes that shape the current information society in which we are immersed. As a complement to this curricular review, it would be highly interesting to carry out an exhaustive review of school textbooks, as has been done in other studies at European level (Senegačnik 2010; Komac, Zorn and Ciglič 2013; Senegačnik 2018). The analysis of school textbooks represents one of the great lines of research in teaching social sciences and, according to Souto González (2002), is one of the key tools in the didactic programming of a class.

Landscape didactics promotes the acquisition of geospatial skills and fosters skills in specific applications. Landscape studies and geospatial technologies applied to didactics constitute one of the educational challenges in Geography (García de la Vega 2014). In this respect, it seems appropriate to take advantage of the ease of access to this great variety and quantity of resources to promote quantitative and qualitative progress in the study of the landscape. These resources should contribute to the formation of the students' ability to manage and interpret the information, as well as to contrast the data from field work with those obtained from other sources (Busquets 2010).

The primary education curriculum of the Autonomous Community of Galicia organises the contents by thematic blocks in order to »facilitate the curricular realisation of the area and of the stage« (Decree 105/2014, 37,478). In this way, the contents, evaluation criteria, learning standards and key competences are organised around four thematic blocks: Common contents, The world that surrounds us, Living in society, and Traces of time. In the first of these, the common contents of the area are established, alluding to the »different techniques, strategies and working methods that enhance and favour the acquisition of learning about the knowledge of the environment by the students«. In the same way, the curriculum also has a special consideration in this block with information and communication technologies when it comes to »searching for information, simulating processes and presenting conclusions regarding the social sciences« (Decree 105/2014, 37478).

The first thematic block organises the common contents in fifty-eight themes, of which only twenty-four are different or slightly different. This means that, of all the subjects proposed for the six primary education grades, almost two thirds are identical. From our point of view, this thematic block does not contribute to achieving the proposed objectives, nor to constituting the fundamental axis in order to deal with the curricular elements of the other thematic blocks. This reiteration of content, as well as of the evaluation criteria and learning standards lead us to reflect on whether this thematic block should have a place in the curriculum as its own block. If so, the contents should be rethought, and specific topics should be proposed and adapted to each course and to the contents of the other three thematic blocks. As designed, perhaps a list of common suggestions for the entire stage of primary education would have been more useful.

The weaknesses that were detected in the organisation of the contents in block one are also applicable to the rest of the thematic blocks. The first thematic imbalance is seen between blocks two, three and four, since half of the topics are included in block two, The world that surrounds us, while only a quarter of them are dedicated to studying block four, The Traces of Time. This imbalance is not justified nor is it coherent with what is included in the curriculum itself when describing the contents of this thematic block by stating that »it is important for students to acquire the historical references that allow them to develop a personal interpretation of the world through basic knowledge of the history of Galicia and Spain, respecting and valuing common and diverse aspects« (Decree 105/2014, 37479).

The thematic decompensation that was detected in the different thematic blocks in which the curricular contents are organised in primary education, was also evidenced in the number of topics assigned to each of the courses of this educational stage. There is a notable difference between the number of topics proposed for the first three courses and the last three and, although the depth of analysis and content are greater in the higher level courses, this inequality is not justifiable. The fourth and fifth year gather half of the topics of the entire educational stage destined to study block two, The world that surrounds us, and something very similar happens in the case of fifth and sixth years, which concentrate half of the topics of thematic block three, Living in society, and block four, The tracks of time. However, only two of the forty-six topics are suggested for the first year of primary school in thematic block four, The Traces of Time, and five of the seventy-six topics in thematic block two, The world that surrounds us.

Of the four thematic blocks in which the curriculum is organised, the ones that refer to the study of society, the economy and the natural environment are, the second, The world that surrounds us, and the third, Living in society. Although the contents proposed for these two thematic blocks allude to the study of geography, the curriculum only makes explicit mention of this discipline in the second block, where »the study of geography is carried out, both of the immediate environment, bringing students closer to the reality they know, such as more distant contexts […] includes content that encompasses the universe, the representation of the earth and orientation in space, water, responsible consumption, climate, climate change, the landscape and its main elements« (Decree 105/2014, 37479).

The study of geography that is presented in the curriculum in block two, The world that surrounds us, is limited exclusively to physical geography content and, in our opinion, with an uneven level of detail and a very transmissive model centred approach. In this regard, almost half of all the topics proposed in this block in all courses of the educational stage are related to the weather, the climate and various aspects related to cartography (plans, maps, scales, orientation in space, etc.).

The contents of block three, Living in society, are aimed at »understanding the characteristics of different social groups« as well as »the production and distribution of consumer goods, production sectors, the economic life of citizens, the entrepreneurial capacity« (Decree 105/2014, 37478). This block presents a reduction in the number of topics with respect to block two of twenty-five percent, which leads us to reflect if, in the curriculum of primary education in Galicia all issues related to physical geography (time, climate, lithology, etc.) have more interest than human geography and the different social aspects (Armas Quintá, Rodríguez Lestegás and Macía Arce 2018).

In relation to the study of the landscape in the curriculum of primary education of the Autonomous Community of Galicia, all the topics that are proposed are included in block two, The world that surrounds us, since this is also included in the basic curriculum of the area of social sciences of Primary Education (Royal Decree 126/2014). If we consider the contents that make specific reference to the landscape, eight topics out of the seventy-six that are proposed for the entire educational stage are included in the second block, and these are present in all courses except the first. Even though this represents ten percent of the subjects, if the evaluation criteria and the learning standards are analysed, it can be observed that most of them are repetitive, changing only and exclusively the scale of analysis.

Several examples can be found in the following topics that appear in the curriculum. In the third year of primary school, the contents include »Landscape: definition, basic elements that characterise the landscapes of Galicia«; in fifth year, »The landscape: elements that form it, types of landscapes«; and, in sixth year, »The landscape: elements that form it, types of landscapes«. Something similar happens with the subject that is proposed for the fourth year of primary school, »The geographic diversity of the landscapes of Galicia«; for the fifth year, »The geographical diversity of the landscapes of Spain«; and, for sixth, »The geographical diversity of the landscapes of Europe«. This fact is also seen in the evaluation criteria and learning standards.

The evaluation criterion »Explain what a landscape is, identify the main elements that it is composed of, and the characteristics of the main landscapes«, appear in third, fifth and sixth years, varying only the scale of analysis. In the learning standards, the same dynamics are followed, with a good part of them being repeated in the different courses of the educational stage, also varying the scale of analysis. We have examples of this in the standards »Define landscape, identify its elements and recognise the main types of landscape« which appears exactly the same in third, fifth and sixth. Along with this, in the learning standards of the topics dedicated to the study of the landscape, a direct and systematic relationship of the landscape with the relief units and the hydrographic slopes is made. This can be seen in the learning standards that are collected in the topics dedicated to landscape for the third course, »Locate on a map the main elements of the landscape: relief units and the most important rivers of the autonomous community; the fourth, »Locate on a map the main relief units in Galicia and its hydrographic slopes«; the fifth, »Locate on a map the main relief units and their hydrographic slopes«; and the sixth, »Locate on a map the relief of Europe, its watersheds and its climate«.

After analysing the contents related to the landscape in the curriculum of primary education of the Autonomous Community of Galicia, it can be seen that these are closely related to physical geography, as well as a prominent presence of the transmissive teaching model to the detriment of promoting teaching of an active, reflective, and critical geography. This fact is appreciated in learning standards that are intended to describe, define, name, identify, locate or place. Descriptive geography is constructed from a juxtaposition of supposedly objective and neutral statements that are destined to be reproduced at the time of evaluation. The master class predominates, almost always supported by the textbook, while the use of other material such as maps, graphics, images or documents is only intended to illustrate or confirm the stated knowledge. The rhythm of the lecture hardly leaves time for the students to raise doubts or questions, and the intellectual activities demanded of the students are almost always of the same nature: to identify the knowledge enunciated by the teacher and present in the textbook, and to reproduce it in an exam (Rodríguez 2002). All these deficiencies are in line with what Macía et al. (2017) point out on the problems that some students show when remembering concepts or reflect on ideas that were explained in previous courses.

The approach that is proposed for the study of landscape in the primary education curriculum of the Autonomous Community of Galicia is far from what the scientific community suggests in this regard, starting with the European Landscape Convention. It indicates the need to conserve the natural but also the cultural heritage, as well as to recognise all the forms of the landscape; the natural, the rural, the urban, the periurban and the ordinary, as well as the emblematic ones (Council of Europe Landscape Convention 2000). Authors such as Liceras (2013) point out that the landscape is portrayed as a complex reality where nature and culture mix, and that knowing a landscape means more than knowing a portion of a territory and having to study the social groups and peoples that inhabit it. There is also an emphasis, in the scientific literature, on conceiving landscape studies at school from a double perspective. On the one hand, instructing students in certain specific contents and, on the other, educating them in the cultivation of a reflective and critical spirit (Gómez Ortiz 1993).

5 Conclusions

Although references to landscape are very present in the school curricula of primary education, as well as the concern of society for the environment, in the case of Spain in general, and in the Autonomous Community of Galicia in particular, the curricular approach that was designed for the study of landscape can be greatly improved and is far from the suggestions in this regard expressed in the scientific community and in the European Landscape Convention itself. In the curriculum review that was carried out for primary education in Galicia, as well as in the basic curricula at the national level, it was revealed that many of the aspects for landscape study and landscape education are not considered. Both the scientific literature and the European Landscape Convention emphasise the need to conserve the natural heritage but also the cultural one, as well as to recognise all the forms of landscape, the emblematic and the ordinary. Knowing a landscape is more than knowing a portion of the territory, it is important to study the social groups and peoples that inhabit it.

In the review of the primary curriculum in Galicia, it was considered that the study of landscape is limited, in general, to the physical elements and to its natural aspect, and to a lesser extent to the environmental problems derived from the action of human beings. At times it seems that the term landscape and environment are confused given that content related to the environment is also included in other topics in the curriculum. The presence of landscape in the curricula of primary education is scarce, although these limitations are more pronounced in the stage of secondary education. Along with this, it should be noted that the contents related to landscape are closely related to the transmissive model instead of promoting the teaching of an active, reflective, and critical geography. This aspect is pointed out in the scientific community, where the need to instruct students in certain curricular areas, strengthen specific contents, but also to educate in the cultivation of a reflective and critical spirit is emphasised. Therefore, a thorough curricular review is necessary in primary education in Galicia, and also of the basic curricula at the national level to achieve the objectives of studying landscape and educating in landscape.

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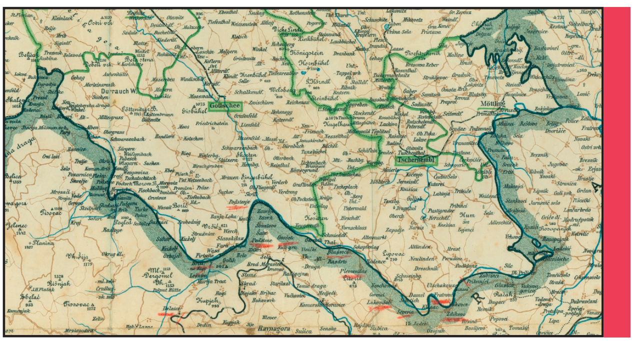
Acta geographica Slovenica, 62-1, 2022, 65–76

THE KOLPA AS A BORDER RIVER IN THE NEWSPAPER SLOVENSKI NAROD, 1868–1914

Marko Zajc



LECHNER'S GENERAL MAP OF CARNIOLA, 1910

The Kolpa as a border river between the Austrian and Hungarian parts of the Habsburg Monarchy.

DOI: https://doi.org/10.3986/AGS.7555
UDC: 94:341.222(282.24Kolpa)»1868/1914«
COBISS: 1.01

Marko Zajc[1]

The Kolpa as a border river in the newspaper Slovenski narod, 1868–1914

ABSTRACT: The article analyzes the portrayal of the Kolpa as a border river in the leading Slovenian liberal newspaper Slovenski narod from 1868 to 1918. A border river is understood both in terms of the political concept of a border river and in terms of a natural border in a landscape. The differences between these two concepts can occur over long historical periods and can change significantly (e.g. due to floods, changes in the riverbed and the loss or acquisition of the status of a border river). In the period examined, the Kolpa formed an internal border between the Hungarian and Austrian parts of the Habsburg Monarchy. In addition, since the Late Middle Ages it has been a political border between Carniola and Croatia. The article analyzes the following aspects: a) the Kolpa as a border and a political concept, b) the management of the Kolpa (construction and maintenance of bridges, traffic bans, and restrictions), c) the Kolpa as a dangerous river, and d) border disputes.

KEY WORDS: environmental history, border, border river, newspaper Slovenski narod, nineteenth century, Kolpa, Slovenia, Croatia

Kolpa kot mejna reka v časopisu Slovenski narod 1868–1914

POVZETEK: Članek analizira podobo mejne reke Kolpe v osrednjem liberalnem slovenskem časopisu Slovenski narod v obdobju 1868–1918. S pojmom mejne reke razumemo politični koncept mejne reke in reko kot naravno mejo v pokrajini. Med obema v dolgem trajanju prihaja do neskladij in se lahko se močno spreminjata (poplave, spreminjanje struge, izguba/pridobitev statusa mejne reke). Kolpa je v obravnavanem obdobju pomenila notranjo mejo v habsburški državi med ogrskim in avstrijskim delom monarhije, obenem pa je bila uveljavljena politična ločnica med Kranjsko in Hrvaško od poznega srednjega veka dalje. V članku analiziramo naslednje vidike: a) mejna reka Kolpa kot politični koncept b) upravljanje s Kolpo; c) Kolpa kot nevarna reka; d) mejni spori.

KLJUČNE BESEDE: okoljska zgodovina, meja, mejna reka, časopis Slovenski narod, 19. stoletje, Kolpa, Slovenija, Hrvaška

The article was submitted for publication on August 13th, 2019.
Uredništvo je prejelo prispevek 13. avgusta 2019.

[1] Institute of Contemporary History, Ljubljana, Slovenia
marko.zajc@inz.si

1 Introduction

1.1 Purpose

This article presents a historical analysis of references to the Kolpa as a border river in the leading Slovenian liberal newspaper »Slovenski narod« (Slovenian Nation) from 1868 to 1918. The basic hypothesis is that in the newspaper the ideological and political dimensions of the border river were mixed with the dimensions of its geography and environmental history. The discourse on a border river as a landscape element is not ideologically and politically neutral and, conversely, the political discourse on the border river cannot avoid being attached to the landscape. This article analyzes the following aspects: a) the Kolpa as a border river and political concept, b) the management of the Kolpa (construction and maintenance of bridges, traffic bans, and restrictions), c) the Kolpa as a dangerous river, and d) border disputes.

1.2 The characteristics of border rivers

Border rivers have different dimensions. They can be large and significant (e.g., the Danube) or serve only as small spatial divides, that can serve the function of a boundary over long historical periods (e.g., the Čabranka; Perko et al. 2019). From a global perspective, borders on rivers vary significantly. They usually run along the line of the lowest elevation within river valleys or the deepest river channel (i.e., the thalweg), but not always. Some borders follow river banks, a middle line between two banks, or the meanders of the river. Countries may also agree to use different principles to regulate river borders. Changes to borders can also occur due to erosion, which can change the banks, the middle line, or thalweg to the benefit of one country and to the disadvantage of another (Gleditsch et al. 2006).

In common concepts of a border river, the riverbed and the border line coincide, but between the two significant changes can be visible in the landscape and on maps. The two elements have a special relationship: the border line is usually defined based on the riverbed. In addition, the border line can also have a reciprocal effect on the riverbed (i.e., human activities on the river). Due to meandering and erosion, the river does not »stick« to the riverbed that cartographers or land surveyors recorded at a particular time in history. The border line may also change due to political or administrative changes (Zajc 2017).

Rivers are natural features with their own dynamics that humans can never fully control. Border rivers, in turn, are social and political concepts that people assign to natural rivers. According to the standard sociological definition of a border developed by the classical sociologist Georg Simmel, a border is not a spatial fact with social effects, but a social fact manifested in space (Eigmüller 2006). Borders have a dual character: they are the result of historical and political processes, and at the same time they are creators of social orders (Eigmüller 2006). A border river is also a social fact, but it is essentially defined as a natural feature. Due to natural river processes (e.g., changes in the riverbed, flooding, and intermittence), border rivers function »in their own right« and also »speak for themselves,« and their activity has social consequences. Conversely, human activity also affects the river. The spatial sciences use different approaches to analyze the relationship between changing river courses and border lines, mainly based on cartographic sources (Zorn, Breg Valjavec and Ciglič 2018; Perko et al. 2019).

1.3 Borders as contact areas

In contrast to the traditional concept of political geography, recent research in political geography has focused on the fact that borders are not merely barriers in spatial communication. A border's impeding effect is not absolute, but relative and selective. It depends primarily on the degree of internal social integration of the border area (Bufon 2001). However, the integration of border areas can often change: Due to the precarious nature of the economic disparity between the two areas on either side of the border – for example, differences in exchange rates, inflation or purchasing power may have a decisive impact on the direction and intensity of relations – cross-border transactions are often unstable (Bufon 2001).

In his article on political geography and contact zones (written before Slovenia's accession to the EU), Milan Bufon highlighted the fact that European integration should invent new operationalization in contact areas. These include not only national identity, but also different ethnic, regional, and linguistic identities, and the borders between them are not always linear or clearly identifiable, and form a complex and »fractal« socio-cultural space (Bufon 2002). Although he relates his finding to present and future European integration, it can also be applied to the past – that is, to the period covered by this analysis (1868–1918). The wider area of White Carniola, the Gorjanci/Žumberak Mountains, and Northern Croatia was undoubtedly a complex and »fractal« area, but also an exceptionally integrated geographical space during this period (Zajc 2003). From today's perspective (i.e. 2019), Bufon's claim seems a little too optimistic, as the border area is integrated and the likelihood of disputes occurring is therefore low. After the crisis of the EU external border system (and the Schengen Agreement) due to the refugee crisis of 2015, it has become clear that integrated contact areas do not prevent border-related conflicts. The same is true for the Slovenian–Croatian border dispute (Pipan 2008), which continues despite the strong mutual integration of border areas (Pipan 2007) and the fact that the matter was settled through international arbitration (Zajc 2018).

The Kolpa region can be defined (both in the period studied and in the present) as a rural peripheral region. Bufon and Sanguin (2015) argue that analyses of marginal rural areas require a different methodological approach. In addition to remote sensing and land-use methods, he also recommends the use of surveys and cognitive maps to compare the current size of perceived areas with the size of historical regions. Historical scholarship can make an important contribution to this type of research: by analyzing archival and journalistic sources, the spatial phenomenon of borders and borderlands can be chronologically contextualized and the dynamic relationship between man, landscape, and sociopolitical systems can be highlighted. Dutch social historians Michiel Baud and Willem van Schendel (1997) developed an interesting chronological classification of border regions: embryonic borderland (pre-modern societies), infant borderland (a border has been established), adolescent borderland (older forms of cross-border networks may continue), adult borderland (social networks accept the border unconditionally), declining borderland (the border loses its meaning), and defunct borderland (the border no longer exists).

Mexican geographer Marcela Aurora Tapia Ladino has highlighted the concept of mobility in the context of borders, which can also be applied to the border area studied here. Borders are largely associated with mobility rather than a static reality, based on territoriality. In terms of border studies, the term mobility is perhaps more appropriate than the broader concept of migrations. Abelardo Morales has developed the concept of cross-border social practices, which refers to activities in which the border plays a key role (Tapia Ladino 2017). The interplay between surveillance and mobility has a long history: it evolved from fears of invasion, disease, and mass migration (Amoore, Marmura and Salter 2008).

1.4 Description of the study area

The Kolpa is a left tributary of the Sava and part of the Black Sea catchment area. It is characterized by a dinaric rain-snow regime and is classified as a karst river (Frantar and Hrvatin 2005). The river canyon cuts through the high karst plateau of Mount Gotenica (Goteniška gora) and the low karst plain of White Caniola. As the groundwater level in the low karst area of White Carniola is close to the surface, lower land areas along the Kolpa are flooded every year. The Kolpa is 292 km long, of which 118 km form the Slovenian–Croatian border. From its confluence with the Čabranka at Osilnica, the Kolpa flows through a narrow valley towards Griblje in White Carniola, with only occasional wider floodplains along the river (e.g., at Osilnica and Kuželj, between Brod na Kolpi and Slavski Laz, and at Dol, Radenci and Vinica). In White Carniola, it flows along the edges of a low karst plain and, apart from its tributaries Lahinja and Dobličica, is fed only by springs directly adjacent to its channel (Komac, Natek and Zorn 2008).

1.5 Historical outline of the Kolpa as a border river in the nineteenth century

In the nineteenth century, the Kolpa separated Carniola (and the Habsburg hereditary lands) from Civil Croatia (and Hungary), though not all the time. The French annexation in the early nineteenth century and the creation of the Illyrian Provinces, caused the Kolpa to lose its status as a border river in 1809. This continued in the first years after the territory was reclaimed by Austria. In 1816, the Kingdom of Illyria was established as part of Austrian Empire, but in reality it never became a separate administrative unit. Under pressure from Hungary, Emperor Francis I finally returned Illyrian Croatia to Hungary in 1822. An administrative-political border with tollbooths and customs offices was restored between Carniola and

Civil Croatia (Zajc 2006). Even though the Kolpa had the status of a border almost on the entire 118 km long section of the present border, it separated more than just Croatia and Carniola. Because of the enclave of Marindol in the Military Frontier on the meander of the Kolpa south of Metlika, until 1881 several kilometers of the river also served as a border between the territory under the military authority of the Military Frontier and Civil Croatia. After 1881, it no longer had the status of a border river in this section.

The nature of borders on the Kolpa River changed several times during the nineteenth century. In addition to the early nineteenth-century changes mentioned above, which resulted from the Napoleonic Wars, there were two other major changes. In the pre-March period, life on the border between Carniola and Croatia was primarily influenced by the customs border between the Hungarian and the rest of the Habsburg Monarchy. From 1822 to 1826, all customs borders between the (western) Austrian provinces were abolished. In 1830, the State Finance Administration was established, to which in Carniola the border customs and salt duty offices in Jesenice (in Lower Carniola) and Metlika were also subordinated (Figure 1). Auxiliary offices for border customs, salt duties, and the Hungarian import tax of 30% (the so-called »thirtieth«) were distributed along the border between Carniola and the Hungarian provinces in Kostanjevica, Vinica, Osilnica, Radovica, Gaberje, Jugorje, Pobrežje, Griblje, Poljane, Trava, Babno Polje, and Krmačina (Keber 2003). After 1836, the general cross-border trade conditions were defined in special monopoly regulations, which show how the border on the Kolpa was used in practice (Hepe et al. 2011).

No special permits were required to transport goods across the border, except for government monopoly goods such as table salt, tobacco, and gunpowder. Travelers carrying foreign tobacco for their personal use were allowed to take up to five Vienna pounds (about 2.8 kg) without special permission. It is also interesting to note the exceptional cases in which transport across the border was permitted on secondary roads. Livestock was allowed to cross the border for grazing or agricultural work, but had to be returned the same day. Transport of goods across the border was not allowed before sunrise or after sunset (Zoll- und Staats-Monopols-Ordnung 1835). Since 1690 tobacco was a monopoly in the Austrian part of the empire, but not in the Hungarian part, and so it was much cheaper in Hungary. Because of the ban on Hungarian tobacco, consumers in the Slovenian lands could obtain it only through smugglers. Smuggling flourished up until the mid-1850s, when the customs border was finally abolished (Zajc 2006).

A second major change to the border at the Kolpa River came with the introduction of state dualism in 1867, from which time, the Kolpa separated two independent halves of the monarchy, sharing foreign policy, finance and the military. In Vienna, the Dual Monarchy was conceived as a federal state based on personal and real union. Common institutions were to demonstrate the unity of the monarchy, which is why Vienna assigned them a key role. For the Hungarian part of the monarchy, however, common institutions were seen merely as the result of the free will of two independent states to regulate certain matters

Figure 1: Metlika (Ilustrirani Slovenec, August 25th, 1929).

jointly (Cvirn 2015). This dual system also had practical implications. As the co-editor of Slovenski narod, Josip Jurčič, wrote in his 1870 article »Slovenci in Hrvati« (Slovenians and Croats), dualism made Croatia a foreign country on the other side of the Kolpa River. Dualism put an end to the border crossing to school because after 1867 Hungarian educational institutions were no longer allowed in the Austrian part of the monarchy and vice versa (Jurčič 1982).

2 Methods

Research has employed methods of conceptual history (Koselleck 2002) and historical discourse analysis, which assumes a constructedness of sociocultural reality and examines the ways in which forms of knowledge are generated in the historical process. Discourses are patterns of order that are inseparable from the forms of power in which the social construction of reality is organized (Landwehr 2008).

Why is the application of the method of historical discourse analysis appropriate for the study of border rivers? Border rivers exist not only in a landscape or in political structures, but also in the media, where they »live« as natural features. The discursive life of border rivers in the context of time and space is key to understanding the phenomenon of border rivers: It allows us to understand the relationships at the level of landscape, politics, and ideology, and it connects the environmental-historical approach with the concept of phantom borders (von Hirschhausen et al. 2015). This research was designed from a long-term (*longue durée*) perspective (1868–1918). It is not a total historical study of all references to the Kolpa River, but a case study based on the principles of drawing from a pool of sources.

Due to its regular publication and its nationalist and liberal orientation, the newspaper Slovenski narod (1868–1945) lends itself to a historical analysis of references to the Kolpa River as a border river over a longer period. This newspaper was largely founded by Slovenian liberal nationalists. After the introduction of the dualist monarchy in 1867 and the adoption of the December Constitution, they sought to develop active Slovenian policy under Habsburg parliamentarism. Slovenski narod became the first regularly published Slovenian political newspaper, and only four years after its appearance it also became the first Slovenian daily newspaper (Vatovec 1968). The newspaper is available at research libraries (e.g. in the Institute of Contemporary History, the National and University Library, and the Slavic Library), and it is also accessible online in .pdf format on the portal dlib.si (managed by the National and University Library). This portal also features a search engine that can be used to search for individual words or phrases in a text, but this is not entirely reliable due to character-recognition errors in scanning historical printed texts. Therefore, the search for material in physical form has been combined with search for material in electronic form.

3 Results

3.1 The Kolpa as a border river and political concept

In the pages of Slovenski narod, the Kolpa River was not only a proper name for a river, but also and above all a symbol of a natural border between the Slovenians and the Croats. It also appeared in articles that had no direct reference to the river itself. The phrase »onstran Kolpe« (across the Kolpa) simply meant Croatian territory. However, this way of defining the location of people based on a border river was not neutral. Slavic or Yugoslav identity was an integral part of Slovenian national ideology at this time. In the Slovenian value system of the time, the Kolpa was a border that existed and did not exist, that connected and separated, or that connected more than it separated. Croats (and South Slavs in general) were considered allies and a »brother« nation (Zajc 2012). In the period studied, the liberal newspaper mostly treated the Kolpa border as an unnecessary nuisance and obstacle in establishing relations between the Yugoslav nations. As the Slovenski narod reported in July 1878, this sad fate created a great barrier on the Kolpa and Sotla rivers that »separated the closest brothers into two, supposedly different nations.« The writer went on to say that history teaches us »that no force can separate nations more than a state border« (Zgodovina nas uči, Slovenski narod 10-160, July 16th, 1878, 1). For the editors and writers of Slovenski narod, however, this dividing force was weaker than the unifying elements. The deputy editor of the newspaper, Ivan Tavčar, stated in Zagreb in 1880 that his heart began to beat faster every time he crossed the Kolpa because he had just crossed the border of his narrow homeland and entered the house of his hospitable brother who (due to Croatian autonomy) lived under freer conditions (Slovenske deputacije v Zagrebu, Slovenski narod 14-289, December 20th, 1881). When in October 1878 the Slovenian representatives in the Carniolan provincial diet again appealed to the Emperor to unite the Slovenians into a political entity (the movement United Slovenia), they also used the Kolpa River to define the borders of Slovenian territory: Slovenia was to encompass the area between the rivers Drava and Mura in the north and northeast, the Adriatic Sea in the southwest, Mount Triglav in the northwest, and the rivers Sotla and Kolpa in the east and south (Adresa poslancev slovenskega naroda na Kranjskem do Nj. Vel. cesarja, Slovenski narod 11-230, October 6th, 1878).

Just like the Sotla, the Kolpa was not only a symbolic border with Croatia, but also a place where Slovenian identity came into contact with Yugoslavism, sometimes literally. When Slovenian nationalists celebrated the official opening of a reading room in Vinica in October 1891, a large Croatian delegation was also present. On the day of the event, the organizers even awaited their Croatian guests on the bridge over the Kolpa, accompanied by the brass band of Črnomelj: »In the middle of the bridge, where the Kolpa separates Croatia from Carniola, Slovenian societies greeted their Croatian brothers« (Iz Vinice, Slovenski narod 24-234, October 14th, 1891, 2). In 1898, Yugoslav enthusiasts writing for Slovenski narod described what was an ordinary trip by Croatian tourists to the Carniolan side of the Kolpa as a manifestation of Yugoslav solidarity. They also reported that the Croatian visitors, who came by boat to the Carniolan side, sang only Slovenian songs to honor the Slovenians (Iz Božakova, Slovenski narod 31-105, May 10th, 1898, 2).

3.2 Management of the Kolpa as a border river: Bridge construction and maintenance

On December 4th, 1872, the deputy of the province of Carniola Josef Savinschegg (alias Jožef Zavinšek), also a landowner from Metlika and member of the »German« party loyal to the constitution, addressed an interpellation to the government in the Carniolan provincial diet regarding the construction of a bridge over the Kolpa River. Savinschegg presented to the government the poor transport connections between White Carniola and Croatia. The only bridge connecting the Croatian and the Carniolan banks of the Kolpa was located at Metlika. From there, there was not a single bridge to be found for the next eleven miles along the river's course. There was a »makeshift raft« at Griblje and Vinica that Croatian landowners had built for anyone who wanted to cross the river, but it was not secured with cables and so was washed away by the river at high water. This isolation from Croatia was all the more painful for Vinica because it was very close to the road between Karlovac and Rijeka on the Croatian side, to which it took the locals only twenty minutes (if they could cross the Kolpa). Savinschegg pointed out that this road was key to selling products

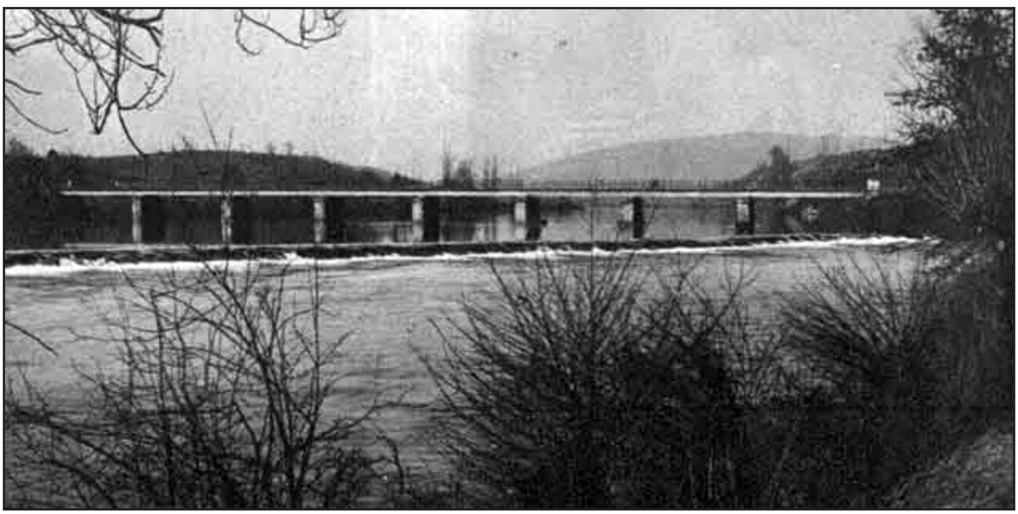


Figure 2: Bridge over the Kolpa near Vinica (Ilustrirani Slovenec, March 15th, 1931).

from Vinica. The inhabitants of Vinica could reach Karlovac, where a livestock fair was held every week, in four hours, provided they could cross the river at Vinica. This was not possible during high water, when it took them more than nine hours to reach Karlovac. In addition, Savinschegg highlighted the fact that the raft at Vinica and Griblje was owned by Croats and that White Carniolans could cross the Kolpa only with their permission. Therefore, he requested the government in Vienna to start negotiations with the Croatian government in order to build a bridge across the Kolpa at Griblje and Vinica (Obravnave deželnega zbora kranjskega v Ljubljani, November 5th–December 7th, 1872; Zasedanje, December 4th, 1872, 90). The provincial governor (i.e. a representative of the central government) replied to Savinschegg that this was a local matter, but that the government was ready to support it (Deželni zbori, Slovenski narod 5-143, December 12th, 1872).

Negotiations with the Croatian side followed. In October 1881, the deputies of the Carniolan provinces agreed to financial participation in the project. It is interesting to note that the Croatian side paid the largest part of the construction costs. Of the nearly 40,000 guldens (the estimated cost of construction), Croatia contributed a full 25,000, while the Parliament of the Carniolan provinces allocated only 7,000 for the construction of the bridge. The remaining 8,000 guldens were to be raised by the local community (Iz kranjskega deželnega zbora, Slovenski narod 14-226, December 10th, 1881). The deputies of the Carniola thought about leasing the bridge to someone who would collect a bridge toll for a few years. This option was rejected because it was more expensive. Since it was a poor region, the inhabitants could hardly have afforded the toll (Obravnave Kranjskega deželnega zbora 1881).

The 125-meter-long bridge over the Kolpa River near Vinica (Figure 2) was officially opened and blessed on October 15th, 1885. Its foundations were laid as early as 1883, but construction was hindered by bad weather. The construction was entrusted to a Croatian company and the work was supervised by a Croatian specialist, but a Carniolan engineer was also involved. The Slovenski narod reports that the greatest credit for the bridge's construction goes to prominent local Janez (or Ivan) Stariha, who persistently lobbied for the bridge in Ljubljana, Karlovac, and Zagreb. Regardless of the wishes of the Carniolan deputies, the bridge could not be completed without the participation of its future users. The bridge was leased and a bridge toll was charged for three years. At the opening ceremony, the above mentioned benefactor Stariha announced that until the beginning of 1886 he had paid the bridge toll »for the folk« out of his own pocket. The report published in Slovenski narod about the ceremony in Vinica nicely shows how the symbolic dimension can be combined with practical reasons. For the ceremony, the bridge was decorated with Imperial Austrian and Slovenian flags on the Carniolan side, and with Royal Hungarian and Croatian flags on the Croatian side (Iz Vinice, Slovenski narod 18-244, October 26th, 1885, 2). The bridge also had to be maintained. In July 1902, the Slovenski narod reported that Carniola had to pay 16,340 crowns for the repair of the bridge at Vinica, of which the local community was to pay 24% (Deželni zbor kranjski, Slovenski narod 34-157, July 12th, 1901).

A railway bridge also had to be built over the Kolpa as a border river between the two halves of the monarchy. White Carniola was relatively isolated in terms of transport, and so efforts to build the White Carniola railway in Carniola began as early as 1864. Croatia was also interested in connecting Novo Mesto with Karlovac, and the railway was also supported by the War Ministry as it offered a direct link with strategically important Dalmatia. However, the Hungarian authorities and the Trieste business circles were against the railway line. Its construction therefore depended mainly on negotiations between the Austrian and Hungarian parts of the monarchy. After the 1906–1907 negotiations between Vienna and Budapest, the green light was finally given for the construction of the railway White Carniola. The Austrian side agreed to build the Carpathian line between Košice and Bohumín, and Hungary agreed to build a line across Croatian territory from Karlovac and Ogulin to Knin (Rustja 1994).

After extensive complications between Vienna and Budapest, and local disputes over the exact route, construction finally began in April 1912. The railway bridge at Metlika was an important part of the project; it was 80 m long and its 432-ton steel structure rested on two 18 m high supporting pillars (Rustja 1994, 105). The Slovenski narod did not report in detail about the construction. In February 1908, it reported that a railway bridge was to be built over the Kolpa near Metlika and that Metlika was to serve as a border station. No final arrangement had been made at that time about the connection with the Croatian line (Z graditvijo belokranjske železnice. Slovenski narod 33-41, February 8th, 1908). The line was completed in 1914, shortly before the First World War. A significant credit for the construction goes to the politician Fran Šuklje, who switched from the liberal to the Catholic faction. Since the Catholic party was predominant in Carniola before the First World War, the liberal newspaper Slovenski narod did not announce its great success: the construction of the railway line White Carniola and its connection with Croatia. Slovenski narod mainly drew attention to the fact that Catholic politicians took all the credit for the construction of the railway, although they had nothing to do with this state project (V hudih stiskah, Slovenski narod 48-120, May 28th, 1914).

The initiative to build the two bridges came from the local environment – that is, local politicians and tradesmen who were aware of the peripheral position of White Carniola in transport and the importance of cross-border transport for the local economy. Both were joint projects by actors from the Austrian (i.e. Carniolan) and Hungarian (i.e., Croatian) sides. What they had in common was that their construction took several years, with longer interruptions due to complexity and high costs.

3.3 Management of the Kolpa as a border river: Traffic bans and restrictions on the Kolpa River

The Kolpa border could be crossed, but the authorities occasionally closed it to prevent the spread of contagious diseases. In June 1874, a correspondent from Črnomelj complained that in their district traffic on the Kolpa River had already been closed for two years, although the cattle disease had long since disappeared (Iz Črnomlja, Slovenski narod 7-130, June 11th, 1874). When this disease appeared in Croatia in 1879, the Carniolan authorities decreed that the local farmers themselves had to stand guard along the Kolpa to prevent the illegal trade in livestock. The guards were appointed by the mayors and supervised by the gendarmerie (Od Kolpe, Slovenski narod 12-104, May 7th, 1879). Already the following year, the cattle epidemic broke out again in Croatia. The Črnomelj district governorship decreed that the provincial border could only be crossed by the bridge at Metlika and the raft at Vinica, provided one possessed all the required permits. When cholera broke out in Croatia in 1886, the Carniolan authorities prohibited Croats from participating in the church festival at the pilgrimage center of the Three Parishes at Metlika (Kuga, Slovenski narod 19-181, August 11th, 1886). The authorities also tried to control the traffic on the Kolpa River itself. They ordered all boats and rafts to remain moored, and oars were confiscated by the municipal authorities (Spet goveja kuga, Slovenski narod 13-113, May 5th, 1880).

Although the Compromise of 1867 confirmed the abolition of internal customs duties to promote free trade between the Austrian and Hungarian halves of the monarchy, trade in goods between them was not entirely free. Hungary, in particular, often resorted to non-tariff barriers to trade in order to protect its own economy. Various mechanisms were used to restrict free trade between Cisleithania and Transleithania: various transit duties, railway tariffs, import bans, innovative use of regulations, state aid, and subsidies. These measures had a similar effect on goods prices as protective tariffs, even if they were not exactly one and the same thing (Schall 2001). Hence, the border at Kolpa could also mean a border between different prices of goods or a border on the conduct of certain business activities.

The Hungarian obstacles to free trade on the Croatian border were also addressed in Slovenski narod. The Carniolan village of Osilnica had problems with the Kolpa border in 1900. The village could be reached with carts only through Croatian territory. When the Hungarian government announced a ban on sugar imports into the lands of the Hungarian crown in 1900, Osilnica realized it was in for big problems. »What are our merchants to do now? Where are they to get the sugar? The nearest railway stations can only be reached through Croatian territory. Are they to carry the sugar from Kočevje on their backs?« The correspondent also suggested that the two governments should reach an agreement on reciprocity: the Carniolans should be allowed to use the Croatian road, and the Croats the Carniolan one (Težave na kranjsko-hrvatski meji, Slovenski narod 33-33, February 2nd, 1900). Two years later the problems had still not been solved. In January 1902, the Slovenski narod published a commentary on Austrian financial policy, claiming that it was cruel to domestic tradesmen. It should take as its model the Hungarian government, which openly protected and promoted the domestic economy, the commentary said. The writer brought the example of Osilnica on the Kolpa River, which was severely affected at times: »The Hungarian administration demands that we meet all the requirements with such severity that you cannot even bring a liter of beer or a kilo of sugar into this municipality – unless you pay taxes for it in Hungary first.« The writer further reported that if a Croat bought a kilo of meat in Carniola, the Croatian financial guards confiscated it and threw it into the water (Birokratizem, Slovenski narod 35-25, January 31st, 1902).

3.4 The Kolpa as a dangerous river

Notwithstanding its frontier status, the river was first and foremost a natural element with its own dynamics. It could also be dangerous. Even though the Kolpa is not considered a frequently flooding river, it regularly overflows its banks in some places. Major floodplains along the river include the area between Griblje and Primostek (about 400 ha in total), between Pravutina and Zaluka Lipnička on the Croatian side, and especially the area along the river meander below the village of Otok on the Slovenian side. The Kolpa often floods the camping and swimming site in Podzemelj. Another large floodplain is located between Križevska vas, Metlika, Rosalnice, and Bubnjarci (Komac, Natek and Zorn 2008).

Thus, in early September 1884, the Kolpa flooded the fields near Metlika just when the farmers were cutting the grass for fodder, and caused great damage (Iz Metlike, Slovenski narod 17-202, September 2nd, 1884). The Kolpa could also claim human lives. In the summer of 1873, the Slovenski narod reported that the hot summer led to many people swimming in the refreshing Kolpa. The writer warned, however, that although the water was clean, it was also very dangerous, having just claimed a child's life »again« (Iz Metlike, Slovenski narod 6-162, July 7th, 1873). Newspapers frequently reported on people drowning in the Kolpa. In June 1880, a couple drowned in it while returning by boat from their relatives on the Croatian side of the river. In this case, the accident was caused mainly by alcohol (Nesreča na Kolpi, Slovenski narod 13-134, June 6th, 1880). During the construction of the railway bridge over the Kolpa, two workers drowned in the river at the end of December 1912. Their boat was overloaded with gravel and it capsized. Although the two workers could swim, they drowned in the cold water (Utonila sta, Slovenski narod 45-300, December 12th, 1912). Sometimes an accident did not end in tragedy. In March 1875, a group of Croats set out for Vinica from the Croatian side. In the middle of the Kolpa, their overloaded boat began to sink. Except for peasant women, everyone else was able to swim, and so the others managed to save the women (Na Kolpi, Slovenski narod 8-67, March 24th, 1875).

3.5 Border disputes

The Kolpa River was dangerous not only because of its natural dynamics, but also because of human activities, often related to the border status of the river. In 1875, the Slovenski narod reported on a long and tragic dispute between Carniolan millers and a Croatian landowner on the other side of the Kolpa. In 1860, the Croatian landowner, Marko Dimitrovič, won a lawsuit in which he got the authorities to ban Carniolan millers from breeding fish behind the mill's dam. The Croatian is also said to have demanded permission to build a mill on the Croatian side, using the water power of the Carniolan millers. Even though the Croatian authorities did not allow this, Dimitrovič began building the mill. Hatred grew, and it came to blows and death threats. This led to tragic events in March 1875, when the Carniolan millers were fishing in the Kolpa with the permission of a Croatian count. Suddenly Dimitrovič appeared and started shooting at them with a revolver. The millers managed to subdue him and knock him to the ground. The revenge was fierce. The furious millers beat him until he lay dead in a pool of blood (Od Kolpe, Slovenski narod 8-144, June 27th, 1875).

4 Discussion

4.1 The border river as a political concept

In the period examined, the Kolpa River was an important administrative and political border between the Austrian and Hungarian halves of the monarchy and also a symbolic border between the two nations, but the Slovenski narod represented it predominantly as a symbolic river connecting two related Slavic nations.

4.2 Management of the Kolpa

Living near a river requires certain activities. This study is about the construction of a road and a railway bridge. The fact that a river also forms a border further complicates the implementation of these activities, requiring communication and coordination between the two entities separated by the river. Due to problems with coordinating and financing the work, authorities on both sides of the Kolpa River often delayed the work to the detriment of the people living along the border.

Even during outbreaks of various diseases, the state invested a lot of energy in controlling the border and trying to seal it off as much as possible. If a river is a good natural barrier on one hand, it also provides good opportunities for illegal movement across the border on the other. The border status of the Kolpa River also came to the fore in economic terms: differences in Austrian and Hungarian laws, and Hungary's non-tariff barriers to trade, created either obstacles or opportunities for cross-border trade.

4.3 The Kolpa as a dangerous river

The Kolpa flooded regardless of its border status, but both entities separated by the river had to deal with the consequences of the flood. Although summer swimming in the river (and the resulting drownings) have no direct connection to the border, historical analysis of accounts of the river revealed situations where the border status of the river led to accidents (e.g., when White Carniolans crossed the river in boats, or when accidents occurred during bridge construction).

4.4 Border disputes

In one of the articles examined, the river as a natural landscape element with certain economic potentials (milling and fish farming) was at the core of a border dispute. Different interpretations of the rights to use the river were also related to its border status. This status significantly complicated the local disputes. The parties involved in these disputes could resolve them in two ways: a) officially, through intervention of the two entities separated by the river, or b) directly, without regard to political authorities. In the first case, the parties have to face lengthy procedures and an unresolved status; in the second case, the resolution of the dispute may lead to acts of violence.

5 Conclusion

From the articles published in Slovenski narod, the main feature of border rivers becomes clear: the inseparable connection between the border river as a social/political concept and the river as a natural feature. A border river is a phenomenon defined by two spheres of completely different character: the social reality and the reality of the natural environment (i.e. changes in the riverbed, floods, or drying up). The interaction between the two spheres is neither simple nor constant, but it can be defined within a historical context. Border rivers are not the only phenomena to which this applies, but they are among the most obvious. Moreover, it is obvious that social reality can also manifest itself in nature. The fact that a river forms a border between two entities also determines the political and social character of the river, and conversely, the fact that a river serves as a border also affects its spatial reality.

ACKNOWLEDGMENT: The author acknowledges the financial support from the Slovenian Research Agency, which supported the research project »Creating, maintaining, reusing: border commissions as the key for understanding contemporary borders« (J6-2574).

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Acta geographica Slovenica, 62-1, 2022, 77–87

TOURISM DEVELOPMENT INDEX OF LOCAL SELF-GOVERNMENT UNITS: THE EXAMPLE OF CROATIA

Vuk Tvrtko Opačić, Zoran Klarić, Ivo Beroš, Snježana Boranić Živoder

VUK TVRTKO OPAČIĆ

Baška on the island of Krk, one of the leading municipalities in Croatia according to the Tourism Development Index.

DOI: https://doi.org/10.3986/AGS.9814
UDC: UDK: 911.375:338.48(497.5)
COBISS: 1.01

Vuk Tvrtko Opačić[1], Zoran Klarić[2], Ivo Beroš[2], Snježana Boranić Živoder[2]

Tourism Development Index of local self-government units: The example of Croatia

ABSTRACT: The goal of the research was to construct a model for calculating the Tourism Development Index (TDI) at the local level. TDI is based on ten indicators: total number of beds, total number of beds per 100 residents, number of beds in hotels and similar establishments, number of beds in hotels and similar establishments per 100 residents, number of tourist arrivals, number of tourist arrivals per capita, number of overnight stays, number of overnight stays per capita, number of employed in tourism and hospitality and share of employed in tourism and hospitality in total employment. Based on TDI, 556 cities/towns and municipalities were categorised into five classes. Due to the usage of both absolute and relative values, TDI recognises the tourism development better than the previously used indices.

KEY WORDS: tourism geography, tourism flow, accommodation facilities, employment in tourism and hospitality, tourist destination, regional development, Croatia

Indeks turističnega razvoja enot lokalne samouprave: primer Hrvaške

POVZETEK: Cilj raziskave je bil zasnovati model izračunavanja indeksa turističnega razvoja na lokalni ravni. Indeks turističnega razvoja je osnovan na desetih kazalnikih: število postelj, število postelj na 100 prebivalcev, število postelj v hotelih in drugih turističnih nastanitvah, število postelj v hotelih in drugih turističnih nastanitvah na 100 prebivalcev, število turističnih prihodov, število turističnih prihodov na prebivalca, število prenočitev, število prenočitev na prebivalca, število zaposlenih v turistični dejavnosti ter delež zaposlenih v turistični dejavnosti med vsemi zaposlenimi. Na podlagi izračunanega indeksa smo 556 hrvaških mest in občin razvrstili v pet razredov. Ker smo uporabili absolutne in relativne vrednosti, indeks turističnega razvoja bolje prikaže razvitost turizma kot indeksi, ki so bili uporabljeni v predhodnih tovrstnih raziskavah.

KLJUČNE BESEDE: geografija turizma, turistični tokovi, nastanitvene zmogljivosti, zaposlenost v turizmu in gostinstvu, turistična destinacija, regionalni razvoj, Hrvaška

The article was submitted for publication on July 15th, 2021.
Uredništvo je prejelo prispevek 15. julija 2021.

[1] Faculty of Science, University of Zagreb, Zagreb, Croatia
vtopacic@geog.pmf.hr (https://orcid.org/0000-0001-9483-3609)

[2] Institute for Tourism, Zagreb, Croatia
zoran.klaric@iztzg.hr (https://orcid.org/0000-0003-3238-6668), ivo.beros@iztzg.hr (https://orcid.org/0000-0002-9467-8546), snjezana.boranic@iztzg.hr (https://orcid.org/0000-0001-8318-691X)

1 Introduction

Tourism is considered as one of the most prosperous, most important and most successful branches of economy in European Mediterranean countries, especially in regions situated along the coast. In order to be able to ensure optimal usage of tourism spatial resources and direct further tourism development, it is necessary to collect reliable statistical data and choose objective indicators of spatial development on national, regional, but also on the local level. Namely, strategic documents in the tourism domain focus mainly on economic aspects and aspects of tourism on the macro level, and focus less on tourism attractions, spatial particularities of tourism and spatial implications on the micro level.

The starting point for the construction of a model for calculating tourism development on the local level, was the need to exactly determine the level of tourism development in local self-government units (cities/towns and municipalities), with the goal of increasing efficacy and transparency in tourism planning. The authors developed a method in the frame of the project »Establishment of a model for calculation of index of tourism development of local self-government units in the Republic of Croatia« for the Croatian Ministry of Tourism and Sports for co-financing the development of touristically underdeveloped parts of Croatia.

The construction of such an index is understood to include definitions of available indicators on the basis of their relevance, dependability, and interdependence; followed by testing for anomalies. This is followed by defining the weight of the indicators used to calculate the index.

There are different approaches for measuring tourism development that have been proposed in previous researches. Baggio (2018) pointed out that on the side of tourism demand, the two most frequently used groups of indicators are those related to tourism flow and tourism expenditure/receipts. Because of the more reliable statistical data, we considered the indicators related to tourism flow as more appropriate for calculating the composite index of tourism development on the local level. Klarić (1990) selected the six most significant indicators used to classify the former (Yugoslav era) municipalities of Croatia in relation to the significance of tourism in the area (number of beds per 100 residents, hospitality object capacity per 100 residents, number of tourist arrivals per capita, number of tourist overnight stays per capita, share of population active in tourism and hospitality in the total population, and the contribution of hospitality and tourism in total GDP).

An analysis of diversification of tourism development level in Poland was undertaken on the local level, based on synthetic indicators that took three groups of variables with different indicators into account: variables of tourism quality (natural and anthropogenic); variables of tourism development; and variables of tourism flow (Derek 2008). In researching the tourist function of rural areas of Poland, Durydiwka (2013) used the following indicators: the number of tourists using accommodation facilities; and the number of companies registered for tourism and catering activities. Borzyszkowski, Marczak and Zarębski (2016) used the Defert tourist function index (DTFI) as the indicator for identification the spatial diversity of tourist function development in the West Pomerania Province in Poland. The Baretje-Defert's index of tourism development, along with Defert's index of tourist traffic density, Charvat's index of intensity of tourist traffic, and Schneider's index of tourism intensity, were used as tourism function indicators in studies regarding the Polish Baltic coast (Parzych 2020) and in the City of Užice in Serbia (Marković et al. 2017). When researching the spatial diversity of tourism in the EU, Roman, Roman and Niedziółka (2020) conducted three cluster analyzes based on: accommodation facilities, tourism traffic, and tourism-related expenditures and revenues.

The use of different indicators of tourism development level is also characteristic of publications dealing with sustainable tourism. Accordingly, the Croatian Environmental Protection Agency determined a list of 266 indicators in 15 thematic areas in order to monitor the environmental changes in Croatia. Tourism is represented by 11 absolute and relative indicators, which mainly relate to tourism flow, accommodation capacity, and the economic and ecological implications of tourism (Kožić and Mikulić 2011). In 2016, the European Commission published the European Tourism Indicator System (ETIS), which identified 43 basic indicators divided into four groups of variables: destination management, economic variables, variables of the social and cultural influence of tourism, and variables of the environmental influence of tourism. Tourism development level is largely covered by economic variables that relate to tourism flow, tourism business, employment in tourism, and tourism supply. Bošković, Vujičić and Ristić (2019) also took the Commission's recommendation into account in their research of indicators of sustainable tourism applied in mountain tourist destinations in Serbia, whereby they selected five groups of variables: economic, tourist satisfaction, cultural, social, and environmental. Pivčević, Petrić and Mandić (2020) analyzed the inter-regional differences among selected Mediterranean regions with regard to sustainable tourism development. As indicators for pressures, they singled out: arrivals in hotels and similar establishments, non-residents, arrivals in hotels and similar establishments, residents, arrivals in other establishments, residents, airport rank, arrivals of tourists/km^2, nights spent/km^2, arrivals of tourists/1000 people, nights spent/1000 people, and number of congresses held in the region.

Curić, Glamuzina and Opačić (2012) measured the level of tourism development of cities/towns and municipalities in Croatia using GIS analysis of seven tourism indicators: number of beds, number of arrivals, number of international arrivals, overnight stays, international overnight stays, number of arrivals per surface area of local self-government units, and number of arrivals per capita. Glamuzina, Madžar and Putica (2017) applied a nearly identical set of indicators in their research of regional aspects of tourism development of Bosnia and Herzegovina. Similar indicators were also used by Šulc and Opačić (2015) to create a typology of tourist resorts in Dubrovnik-Neretva County according to the level of tourism development.

In the research of the influence of tourism on the physiognomic characteristics of the landscape of the interior of Istria, Vojnović (2013) used the tourism functionality coefficient (CTF) for measuring spatial load of tourism, i.e. the number of beds in commercial and non-commercial lodgings per 100 residents. Vojnović (2018) also dealt with the classification of cities/towns and municipalities according to the intensity of tourist activities using multiple indicators: total number of beds; total number of arrivals; total overnight stays; estimate number of town/municipal residents; and town/municipal area.

Aubert, Jónás-Berki and Marton (2013), when constructing the tourism index as an indicator of tourism intensity on the example of Hungary, identified the parameters from both the demand and the supply side.

Table 1: Frequently used indicators of tourism development level.

Group of indicators	Indicators
Indicators of tourism flow	• number of tourist arrivals • number of foreign tourist arrivals • number of tourist arrivals per capita • number of tourist arrivals per 100 residents (intensity of tourism flow) • number of tourist arrivals per km^2 • number of day trippers • number of overnight stays • number of foreign overnight stays • number of overnight stays per capita (coefficient of intensity of tourism flow) • number of overnight stays per day per 100 residents (tourism penetration rate) • number of overnight stays per km^2 • number of tourist arrivals or overnight stays per day in a given area (km^2) (tourism density rate) • number of overnight stays according to types of accommodation • level of accommodation vacancy • average tourist stay (in days) • seasonality of tourist arrivals shown in the share of the number of tourist arrivals in and out of season
Indicators of tourism supply	• number of beds • number of beds per 100 residents (coefficient of tourism functionality) • number of beds per km^2 • number of beds in hotels and similar establishments in the total number of beds • number of seats in hospitality/gastronomic objects per 100 residents (apart from lodgings)
Indicators of tourism in the local economy	• share of those employed in hospitality and tourism in total employment • share of GDP generated by hospitality and tourism in total GDP of a destination • tourist expenditure per capita in a destination • daily tourist expenditure • value of hospitality traffic (specific tourism traffic coefficient) • share of businesses in the tourism sector in the total number of businesses • share of food, drink, and other goods and services in the tourism supply of the destination • share of seasonal jobs in tourism available in the destination

The number of guest nights spent at commercial and private accommodations is recognised as the main indicator from demand side.

Finally, the former Croatian Regulation on the criteria for categorising settlements into tourism classes (2009) was based primarily on the number of registered overnight stays, although it also listed other quantitative and qualitative criteria by which Croatia's 556 cities/towns and municipalities were classified into classes: 17 into class A, 8 into class B, 15 into class C, 364 into class D, while 152 touristically underdeveloped municipalities were not mentioned. The Regulation was abandoned partly due to numerous illogicalities (the class of a given city/town or municipality could significantly change based on the registration of a single lodging facility), and partly due to issues with collecting data.

Based on an overview of the presented literature, we can conclude that the list of commonly used indicators is very extensive and impossible to measure annually in different countries (Table 1).

Previous models for calculating tourism development revealed a lack of ability to change class boundaries every year or every few years without compromising the basic concept of the calculation. Therefore, the ability for simple collection of data on an annual basis and minimisation of the influence of special circumstances (e.g. the COVID-19 pandemic) on the determination of classes were the important goals in the creation of a new model for calculating the composite tourism development index on the local level.

The goal of this research was to create a model for calculating the Tourism Development Index (TDI) on the local level. Based on identified disadvantages of previous studies, we wanted to develop a new model that would ensure: a) dynamic approach towards measuring tourism development with annually available statistical data; b) composite index that has a proper balance between sensitivity and robustness; c) internationally applicable model for local self-government units that can be useful for evidence-based tourism policy.

2 Methods

For the purposes of this research, the ten basic indicators of tourism development level are selected. There are five indicators based on absolute values and five corresponding indicators based on relative values (per capita or similar). All the indicators simultaneously indicate all key aspects of tourism, and are exact and available annually. The indicators are:

- Total number of beds and Total number of beds per 100 residents represent the potential for tourism development in a given area.
- Number of beds in hotels and similar establishments and Number of beds in hotels and similar establishments per 100 residents highlight areas that have a well-developed overall tourism supply, which generates higher revenues from tourism compared to areas where there are relatively few such facilities.
- Number of tourist arrivals and Number of tourist arrivals per capita indicate how attractive an area as a whole is, and thus greatly compensates for the difficulty in collecting comprehensive data on the number of visits to attractions in a given area, i.e. when entry is not charged. This indicator additionally emphasises the tourism potential of local self-government units that are oriented toward year-round tourism, and areas where tourists have relatively short stays.
- Number of overnight stays and Number of overnight stays per capita are the indicators of the total effect of tourism in a given area that is used the most, despite not offering a sufficient picture of tourism potential and attractiveness, and highlights areas with large shares of complementary capacity and relatively low tourism expenditure.
- Number of employed in tourism and hospitality and Share of employed in tourism and hospitality in total employment are significant as the indicators of the importance of tourism in creating jobs. Therefore, these indicators show the importance of tourism as a development engine for the continental Croatia. Also, both indicators implicitly consider same-day visitors because same-day visitors increase tourism demand in the area, and more employees are needed to satisfy their requirements.

Indicators based on absolute values are important for showing the total significance of tourism in a given area. Large absolute values of all five indicators are generally shown only in larger cities, while (apart from rare exceptions) all municipalities with relatively few residents also showed lower absolute values for the majority of indicators. Indicators based on relative values are important for showing the significance of tourism for locals, i.e. how dependent a given area is on tourism. In contrast to absolute indicators, extremely high values of all five relative indicators were generally only found in smaller towns and municipalities on the Croatian coast and islands, where tourism was the dominant economic activity.

Data from 2019, the last year before the COVID-19 pandemic, were used in the research: tourism statistics from e-Visitor (https://www.evisitor.hr), official population estimates provided by the Croatian Bureau of Statistics (Towns in statistics, Population – Estimate and natural change), as well as data regarding the number of persons employed in hospitality and gastronomy (Employment – Review by counties).

The Tourism Development Index (TDI), as a composite index, was obtained from the values of ten indicators of tourism development on the level of cities/towns and municipalities. Because the indicator values differed according to both range of value and measuring unit, a combination of linear and logarithmic transformation was applied to get normalised values of indicators (Booysen 2002; OECD 2008; Chakrabartty 2017). For any indicator x_i, referential value of the indicator R_i was chosen as the arbitrary value close to the highest value of indicator across all cities/towns and municipalities. The normalised value z_i for the given value of indicator x_i was obtained by

$$z_i = \log_{10}\left(1 + \frac{10.000}{R_i} \cdot x_i\right),$$

where $\log_{10}$ is the logarithmic function to the base of 10. Due to the choice of R_i, the highest normalised values are around 4. Referential values for all indicators are presented in Table 2.

Table 2: Referential values of indicators.

Number	Indicator	Referential value
1.	Total number of beds	25,000
2.	Number of beds in hotels and similar establishments	10,000
3.	Number of tourist arrivals	1,000,000
4.	Number of overnight stays	2,000,000
5.	Number of employed in tourism and hospitality	5,000
6.	Total number of beds per 100 residents	1,000
7.	Number of beds in hotels and similar establishments per 100 residents	100
8.	Number of tourist arrivals per capita	100
9.	Number of overnight stays per capita	1,000
10.	Share of employed in tourism and hospitality in total employment	100%

TDI was calculated as the sum of the normalised values of all ten indicators. The obtained values were used to classify cities/towns and municipalities into five classes. The ranges of values for each class are presented in Table 3.

Table 3. Values of TDI by class.

Class	Value of TDI
I	≥ 30
II	20.00-29.99
III	10.00-19.99
IV	0.01-9.99
0	0

It is noteworthy that the scaled values of Baretje-Defert's index of tourism development, Charvat's index of tourism intensity, and Schneider's index of tourism intensity (Parzych 2020) are among the indicators used in TDI calculation. The correlation between TDI and previously mentioned indices exists, but it is not particularly strong (Table 4).

Table 4: The Pearson correlation coefficient between the Tourism Development Index (TDI), Baretje-Defert's index of tourism development (I_{BD}), Charvat's index of tourism intensity (I_C), and Schneider's index of tourism intensity (I_S) for all the self-government units in Croatia.

	TDI	I_{BD}	I_C	I_S
TDI	/	0.61	0.62	0.56
I_{BD}			0.94	0.98
I_C				0.96
I_S				/

3 Results

All 556 cities/towns and municipalities in Croatia were classified according to the Tourism Development Index (TDI) (Figure 1).

In class I, we find all of the most significant Croatian tourist destinations with high values of absolute indicators, we also find large cities in which tourism is not the dominant economic activity such as Zagreb, Split, Zadar, Šibenik, and Pula. We also find smaller municipalities and cities/towns with high values of relative indicators in this class, in so far as they possess a tourism supply capable of attracting a large number of tourists. The highest values of TDI were found in the three most important Croatian tourist destinations: Rovinj, Poreč, and Dubrovnik, followed by cities/towns and municipalities with moderately high accommodation capacity in relation to their size: Medulin, Umag, Tar-Vabriga, and Mali Lošinj (Table 5). Apart from Zagreb, in the continental part of Croatia, we only have the municipalities of Rakovica and Plitvička Jezera in class I. There were 56 cities/towns and municipalities in Croatia in 2019 classified as class I.

Cities/towns and municipalities in class II are also developed tourist destinations, but some of them are ranked lower due to the total number of tourists and overnight stays (relative to their size) or, in the case of larger cities, due to the weaker influence of tourism on the local economy. Belonging to class II, however, can be seen as an advantage, because it indicates lower dependence on tourism. Therefore, class II includes the majority of the remaining cities along the Croatian coast (e.g. Trogir, Senj, Rijeka) and all larger cities and municipalities in continental Croatia that are established tourist destinations. Thus, in class II we have important urban continental destinations like Osijek, Varaždin, Karlovac, and Vukovar, and tourist towns such as Slunj, Otočac, Gospić, and Ogulin, as well as towns and municipalities where the most popular Croatian hot springs are located (Tuhelj, Sveti Martin na Muri, Stubičke Toplice, Krapinske Toplice). In 2019, 96 towns and municipalities in Croatia belonged to class II.

In class III there were 154 self-government units in 2019. In this class, we have the majority of the remaining continental cities/towns in Croatia, and small tourist destinations (that have potential) like Kneževi Vinogradi in Baranja or Bednja with Trakošćan Castle in Hrvatsko Zagorje. In class III, we also find a moderate number of municipalities with poor tourism valorisation on the Croatian coast such as Novigrad (near Zadar), Nerežišće on the island of Brač, and Janjina on Pelješac Peninsula.

There are no cities/towns or municipalities from the Croatian littoral in class IV. This class mostly consists of cities/towns located in continental Croatia, e.g. Zlatar, Čazma, Lipik, or Pleternica, indicating the need for stronger tourism valorisation. In 2019, there were 195 towns or municipalities in class IV.

Class 0 (the lowest level) is made up of municipalities that show values of 0 according to all indicators. There were 55 such municipalities in 2019 and all were found in the continental Croatia, apart from Pojezerje in Dubrovnik-Neretva County. No Croatian cities/towns showed 0 for all indicator values.

4 Discussion

In this research we have developed a new model for calculating the Tourism Development Index (TDI), as the composite index of tourism development, that fulfils three objectives. Firstly, the index is based on annually available statistical data that ensure dynamic approach towards measuring tourism development. If the index should track changes in tourism development annually, it is important to have easily accessible and reliable statistical data, which, according to Aubert et al. (2013), is a frequent obstacle in calculating similar indices.

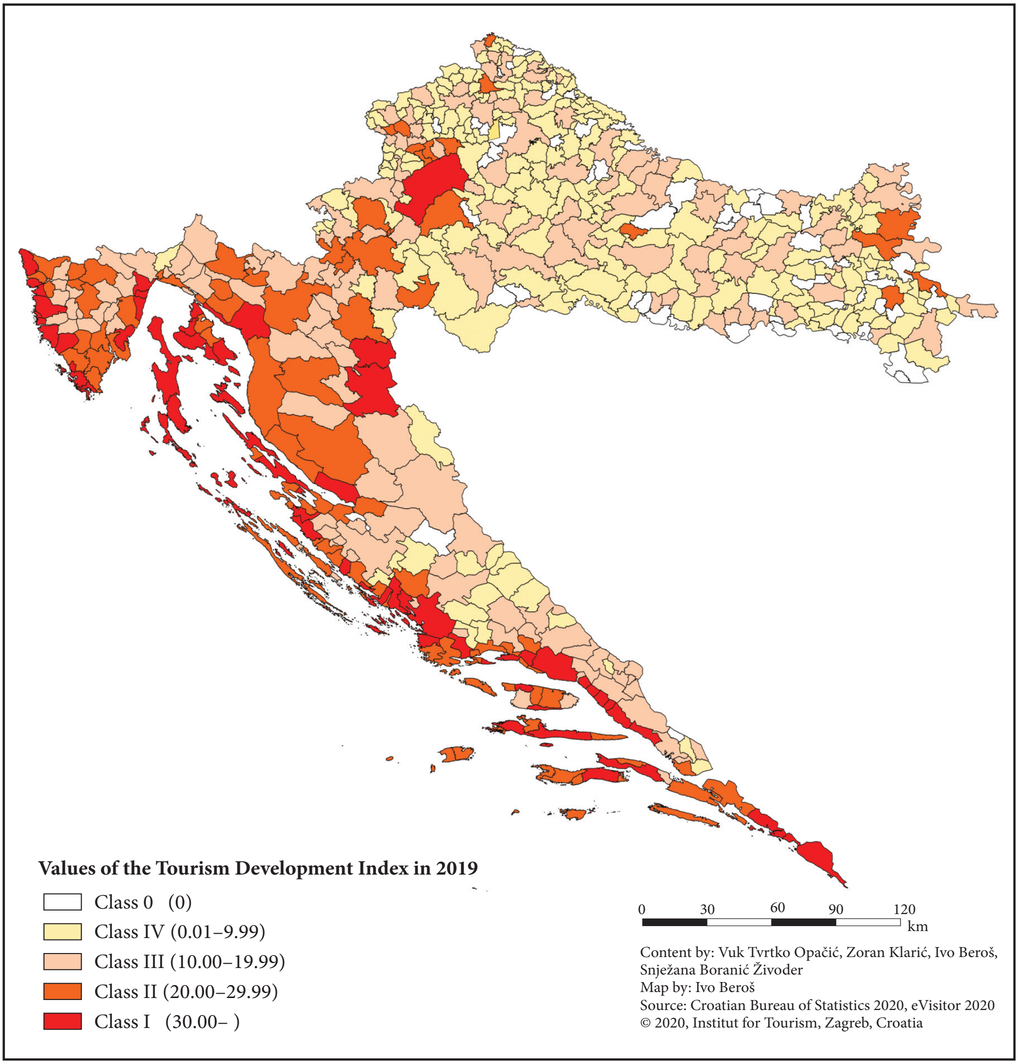

Figure 1: Cities/towns and municipalities in Croatia according to values of TDI in 2019.

Table 5: Top ten cities/towns and municipalities in Croatia according to TDI 2019 (Croatian Bureau of Statistics; e-Visitor).

Rank	City/Town; Municipality	County	TDI
1.	Rovinj	Istria	37.57
2.	Poreč	Istria	37.16
3.	Dubrovnik	Dubrovnik-Neretva	36.81
4.	Medulin	Istria	36.14
5.	Umag	Istria	36.05
6.	Tar-Vabriga	Istria	35.89
7.	Mali Lošinj	Primorje-Gorski Kotar	35.81
8.	Podgora	Split-Dalmatia	35.70
9.	Baška	Primorje-Gorski Kotar	35.43
10.	Tučepi	Split-Dalmatia	35.39

Secondly, this index has a proper balance between sensitivity and robustness, since it is constructed from important data which reflect significant changes in tourism development at the local level. One of the most commonly used tourism index is Defert tourist function index (DTFI). However, basing the analysis on only one indicator can lead to incomplete conclusions, as Borzyszkowski, Marczak and Zarębski (2016) pointed out, citing the example of unregistered accommodation capacities. TDI therefore balances both supply and demand side indicators to minimize the lack of reliable data on both sides. The importance of using indicators on both demand and supply side has been highlighted by Aubert et al. (2013).

Thirdly, the proposed model covers the entire territory of Croatia. It can easily be applied in other countries by setting the referential values (Table 2) close to the highest values of the indicators for a particular country or area. With regard to Parzych (2020), who pointed out the problems of comparing the results of tourism indices in areas of different size, TDI can be applied not only locally, but also regionally and nationally because all indicators used for its construction are available and comparable at all statistical levels.

Finally, TDI places greater significance on the self-government units with large population. For example, Dubrovnik, Split, Zagreb, Pula and Zadar are among the top ten self-government units in Croatia according to the number of overnight stays and the population of those cities is larger than 40,000. According to the TDI, they are ranked 3, 46, 57, 37 and 43, respectively, but, according to e.g., Charvat's index of tourism intensity, they are ranked 72, 142, 202, 122 and 128. The use of Schneider's index of tourism intensity or Baretje-Defert's index of tourism development produces similar results.

Table 6: Cities/towns and municipalities in classes by values of TDI in Croatia and recommendations for the efficient spatial organisation of tourism boards.

Class	Basic features	Challenges for further tourism development
I	Includes the most important tourist destinations in Croatia upon which Croatian tourism is based, i.e. cities/towns and municipalities in which tourism has a key role in the local economy.	Due to the high level of tourism development, these destinations are largely faced with problems of acceptable accommodation and monoculture tourism. For further development, incentives are needed for achieving sustainability and balance in development and improving the level of competitiveness on the international tourism market. These destinations should have independent local tourism boards or be the seat of the tourism board for the wider area.
II	Includes the remaining important tourist destinations in Croatia, i.e. cities/towns and municipalities in which tourism has an important role in the local economy, but other activities are of greater importance (than in class I).	Due to the significant level of tourism development, these destinations are often faced with problems of acceptable accommodation and monoculture tourism. For further development, incentive is needed for improving the level of competitiveness on the domestic and international tourism markets. These destinations should have independent local tourism boards or be the seat of the tourism board for the wider area.
III	Includes tourist destinations that are partially developed and therefore need further development incentives; this class also includes cities/towns that have a somewhat developed tourism supply that provides basic accommodation facilities, but the role of tourism in total economic activity is relatively small, due to this, such locations do not function sufficiently as full tourist destinations.	Due to weaker tourism development level, these destinations need, to varying extents, incentives to improve their tourism supply and move to higher classes, especially if they possess valuable tourist attractions that have not yet been valorised. These destinations should be incentivised to join the tourism boards of their greater area, with surrounding cities/towns and municipalities with which they make a logical spatial whole.
IV	Includes cities/towns and municipalities that are just starting to develop touristically and are therefore, not yet tourist destinations.	Due to insignificant tourism development level, these cities/towns and municipalities need various incentive measures to improve their tourism supply and move to higher classes, especially if they have valuable tourist attractions that have not yet been valorised. These cities/towns and municipalities should integrate with tourism boards of cities/towns and municipalities in classes I, II, and III with which they make a logical spatial whole.
0	Includes municipalities in which there is no tourism activity, or where tourism activity is so low that it is not possible to accommodate tourists or properly put local tourist attractions to use.	Due to lack of tourism activity, and with the goal of activating potential tourist attractions, these cities/towns and municipalities should integrate with tourism boards of cities/towns and municipalities in classes I, II, and III with which they make a logical spatial whole.

TDI is an important tool not only in tourism development planning, but also in the overall regional planning. As an example of utilising TDI in Croatia, we can suggest better organisational structure of tourist boards as a part of evidence based tourism policy. Some suggestions for the Croatian case are given below (Table 6).

Given the transparency, relevance, and ease of annual monitoring of such an index of tourism development level, the possibilities for its application are extensive. The two most important applications of this model for calculating the index of tourism development level are: a) its use as a condition for obtaining support for tourism development at the state level, and b) as a criterion for determining the position of a city/town or municipality in the system of tourist boards.

5 Conclusion

Despite the strong development of Croatian tourism from the early 2000s to 2019, in which there were 19.6 million tourist arrivals and 91.2 million overnight stays, the difference between the seven coastal counties (in which 94.6% of all overnight stays were recorded) and the 14 continental counties (with 5.4% of overnight stays) is stark (Croatian Bureau of Statistics 2020). In order to objectively confirm and document the great differences in local tourism development level, we constructed a precise model for calculating the Tourism Development Index (TDI), as a composite index on the ten indicators (total number of beds, number of beds in hotels and similar establishments, number of tourist arrivals, number of overnight stays, and number of employed in tourism and hospitality, total number of beds per 100 residents, number of beds in hotels and similar establishments per 100 residents, number of tourist arrivals per capita, number of overnight stays per capita and share of employed in tourism and hospitality in total employment).

The comparative advantage of TDI is that it allows dynamic approach to measuring tourism development annually and can reflect significant changes in tourism development at the local level. The recommended model has been tested on cities/towns and municipalities in Croatia and is applicable in other countries, which is reflected in the main applicable value of the research. Its implementation could contribute to developing successful tourism policy and more efficient systems of tourism administration in a given area, which would mitigate imbalances in tourism development and better valorise tourist attractions.

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Acta geographica Slovenica, 62-1, 2022, 89–104

TOURISM CARRYING CAPACITY IN THE MUNICIPALITIES OF TOLMIN, KOBARID AND KOMEN

Igor Jurinčič

BLAŽ MOČNIK (© DELO)

Traffic at the confluence of Tolminka and Soča rivers in August 2019.

DOI: https://doi.org/10.3986/AGS.10556
UDC: 911.3:338.48(497.47)
COBISS: 1.01

Igor Jurinčič[1]

Tourism carrying capacity in the municipalities of Tolmin, Kobarid and Komen

ABSTRACT: The study of tourism carrying capacity in the municipalities of Tolmin, Kobarid and Komen has shown that the infrastructural and economic carrying capacity is the most problematic, as most indicator limits are already exceeded in the summer season. The most favourable is the spatial-ecological carrying capacity, where none of the studied indicator limits were exceeded. The results of the carrying capacity assessment for tourism in these municipalities should not be used as a tool to restrict tourism development, but rather as expert recommendations to promote more sustainable tourism development. Infrastructure identified as deficient cannot be improved immediately. Improvements require large financial investments that municipalities are not able to ensure quickly. We need a tourism development strategy that, in addition to all the necessary improvements, comprehensively addresses the problems that municipalities face from overtourism, especially during the high season.

KEY WORDS: tourism carrying capacity, indicators, infrastructure, sustainable tourism, overtourism, Soča Valley, Karst Plateau

Turistična nosilna zmogljivost občin Tolmin, Kobarid in Komen

POVZETEK: Raziskali smo turistično nosilnost v občinah Tolmin, Kobarid in Komen. Ugotovili smo, da je najbolj problematična infrastrukturna in gospodarska nosilnost, saj je večina kazalnikov preseženih že v poletni sezoni. Najbolj ugodna je prostorsko-ekološka nosilnost, kjer ni bil presežen noben od proučevanih kazalnikov. Rezultatov ocene nosilne zmogljivosti za turizem v teh občinah ne bi smeli uporabljati kot orodje za strogo omejevanje turističnega razvoja, temveč kot strokovna priporočila za trajnostni razvoj turizma. Infrastrukturnih zmogljivosti ne moremo povečati na kratek rok, saj to zahteva velike finančne vložke, ki jih občine ne morejo zagotoviti tako hitro. Potrebujemo strategijo razvoja turizma, ki bi poleg vseh potrebnih izboljšav celovito obravnavala težave, s katerimi se soočajo občine zaradi prekomernega turizma, zlasti v visoki turistični sezoni.

KLJUČNE BESEDE: turistična nosilna zmogljivost, indikatorji, infrastruktura, trajnostni turizem, prekomerni turizem, Dolina Soče, Kras

The article was submitted for publication on January 6th, 2022.
Uredništvo je prejelo prispevek 6. januarja 2022.

[1] University of Primorska, Faculty of Tourism Studies – Turistica, Portorož, Slovenia
igor.jurincic@fts.upr.si

1 Introduction

The first studies undertaken on carrying capacity date back to the 1960s. The carrying capacity of an area means the maximum number of people, plants and animals in a given area that can live undisturbed naturally, and which can be sustained in such conditions without reducing the carrying capacity of the environment in the future (Butler 2020). The number of people who can coexist in a sustainable and long-term basis with the environment is therefore defined, without deteriorating the quality of the environment and all its other inhabitants with their presence.

Carrying capacity in tourism means the greatest number of visitors that a tourist destination can accommodate without creating irreversible negative effects on the environment or the local community, while tourist satisfaction remains unchanged (World Tourism Organization 1996).

When analysing the carrying capacity, we are faced with the question as to what extent a certain impact continues to be acceptable and how to properly plan for further development so that it remains sustainable and the carrying capacity of an area is not exceeded. If we do not take into account the carrying capacity of the environment, it means that we have exceeded the permissible capacity limits which, in nature, means a sustainable condition, where nature, despite all the pressures, can renew itself (Mavri 2018a).

The assessment of carrying capacity is a method used to determine the effects of tourism on the environment and relative spaces where we study and assess the impact of interventions in a given area. It is an important part of spatial planning in tourism and represents one of the most important tools in sustainable tourism (Jovičić and Dragin 2008; Jurinčič 2009). The method used in assessing carrying capacity, as we know it today, is more dynamic than in the past. The role of the method has changed, as the purpose is not to create limitations when defining the capacity limit at a single point, but rather a tool through which we can constantly monitor and assess the development in order to use the results as a basis for further management and planning (Coccossis, Mexa and Collovini 2002; Jurinčič 2005).

Regarding the type of carrying capacity, there are several different divisions which are otherwise quite similar. The World Tourism Organization divides the carrying capacity into three types, namely environmental, socio-cultural and psychological (Jovičić and Dragin 2008). Some authors cite a division where there are four types of carrying capacity, namely (World Tourism Organization 1998):

- the environmental carrying capacity which is based on physical and biological factors of selected species without any disturbances,
- the socio-cultural carrying capacity is determined by assessing any unacceptable impact felt by the local community or by restrictions related to the availability of human resources,
- the psychological carrying capacity refers to an acceptable limit of visitor numbers without a decrease in the quality and satisfaction of the experience which differs depending on the type of tourism and the type of activity,
- the infrastructure carrying capacity is determined by the size of the tourist destination's infrastructure, such as the number of rooms as well as municipal and road infrastructure capacity. This is the most stable in the long term as the infrastructure does not change at a fast rate.

Nature conservation areas in the USA were among the first tourist areas where the carrying capacity method was used to manage tourism (Manning 1999). They were followed by other nature conservation areas in Europe (Mandić and Marković Vukadin 2021) and also in Slovenia (Jurinčič and Balažič 2011; Mavri 2018a; 2018b; Jurinčič 2020). According to the method designed by Priority Actions Programme, Regional Activity Centre (1997) with its relative upgrades, carrying capacity analyses for beaches in the Mediterranean were undertaken for Croatia (Klarić et al. 2003; Grofelnik 2020), Slovenia (Jurinčič 2005, 2009), Greece (Tselentis, Prokopiou and Toanoglou 2006; Tselentis et al. 2006; Prokopiou, Tselentis and Bousbouras 2008), Portugal (Zacarias, Williams and Newton 2011), Spain (Baños Castiñeira and Viñals Blasco 2020), Italy (Corbau et al. 2019) and Montenegro (Klarić and Marković 2013).

In the UNESCO heritage destination of the Dolomites in Italy, where they are dealing with the negative effects of overtourism, they have found that the use of technology that enables the monitoring and measurement of overtourism a useful tool, where they could promote an alternative offer for tourists in the vicinity of a crowded main attraction (Bertocchi, Camatti and van der Borg 2021). The importance of mobile applications for directing and regulating sustainable visits to lesser-known tourist attractions was also highlighted by Jurinčič et al. (2013) and Cvetković et al. (2016). After analysing the carrying capacity, they found that the current situation allows a maximum of 4000 visitors to the historic city centre of

Dubrovnik at any one time (Camatti et al. 2020). In the Škocjan Caves Park, which is famous for its exceptional natural beauty, they found (Jurinčič 2020) that 300 visitors could be accommodated in the cave at any one time, or a total of 1800 visitors a day.

Total carrying capacity, according to the adapted United Nations Environment Programme (UNEP) methodology and given the particularities of the destination in question and the use of a smaller number of key carrying capacity indicators, has been reviewed several times in Slovenia at municipality level by Jurinčič and his colleagues. A study of the carrying capacity for the area of the Idrija municipality was undertaken to prepare a tourism marketing strategy there (Ravnikar et al. 2009), and for the Metlika municipality in order to plan the development of tourism along the Kolpa River (Jurinčič 2006) while the municipality of Bled was studied for research purposes (Golob 2011). An important advantage of such an integrated approach is that it offers a combination of environmental, social and economic aspects of the carrying capacity to provide a total carrying capacity for each municipality and region. Such cases are rarely found in relative literature. Another advantage of comprehensive carrying capacity analyses is that it also helps to determine carrying capacity thresholds, despite the fact that we consider and compare different indicators. Although these are subjective estimations of the value of each indicator on a scale of 1–9, they are based on verifiable quantitative data.

The aim of this paper is to answer the question as to whether the carrying capacity for tourism has already been exceeded in the areas of the municipalities of Kobarid, Tolmin and Komen as tourism has increased in these areas significantly over the last decade.

2 Methods

The municipalities of Tolmin and Kobarid in the Upper Soča Valley region and the municipality of Komen in the Karst region are rural municipalities of Slovenia located in the west of the country along the Italian border. The economy is based mainly on industry while tourism has grown extremely rapidly over the last ten years. The Upper Soča Valley and Karst are becoming one of the most important tourist destinations for active holidays in Slovenia. Most of the municipalities of Tolmin and Kobarid are a part of the Triglav National Park and are designated protected areas of Natura 2000. 98% of the Komen municipality is classified as being in the Natura 2000 area. Due to their many natural and cultural attractions, they are proving to be of interest for visitors who are looking for breaks in a clean and peaceful environment which is rich in cultural heritage and offers excellent culinary experiences. The success of tourism in the long term will only be ensured by maintaining good quality tourist-based amenities and other attractive offers.

Based on our experience in carrying capacity analysis for several other municipalities in Slovenia (Jurinčič 2005; Jurinčič 2006; Ravnikar et al. 2009; Golob 2011), we have selected and here discuss nine indicators in more detail for the municipalities of Tolmin, Kobarid and Komen. We assume these indicators play an important role and will consequently provide us with the best overall assessment of the carrying capacity of each municipality for tourism. We have classified them into three different groups of indicators.

Among the spatial-environmental indicators, we have selected:

- surface water quality of the Soča river basin in the Tolmin and Kobarid municipalities and Natura 2000 in the municipality of Komen,
- waste collection and treatment and
- the supply and consumption of potable water.

Among the infrastructure indicators, we selected:

- the number of parking spaces,
- the length of renovated local and national roads, and also cycle trails.

Among the economic indicators, we have selected:

- the number of nights stayed,
- the number of tourists, and
- the number of accommodation facilities.

The individual indicator was assessed by allocating a numerical value according to the predefined carrying capacity framework. As a criterion for easier display, we adopted values on a scale from 1 to 9, where values between 1.0–2.9 mean that the indicator shows a lower level of utilisation of development potential (unused), values from 3.0–5.9 mean that the indicator shows a higher level of utilisation of development potential and does not exceed the carrying capacity (not exceeded), and values between 6.0–9.0 mean that the carrying capacity estimate has been exceeded (exceeded).

The assessment of the carrying capacity for each indicator is based on real data, but we are aware that its numerical representation is somewhat subjective. The carrying capacity of surface water quality of the Soča and Nadiža rivers was assessed on the basis of continuous monitoring of bathing waters of the ARSO. Natura 2000 areas were assessed in terms of biodiversity conservation and the level of awareness of both tourists and the local population about its importance. The waste collection and treatment system was assessed according to the trend of the movement of collected and disposed waste and deemed to exceed the carrying capacity when the amount of disposed waste increases and the proportion of selectively collected waste does not increase. The supply of potable water exceeds the carrying capacity when the potable water becomes scarce and austerity measures are required. Parking spaces exceed the carrying capacity when basically there are not enough of them. The length of renovated local and national roads is exceeded when traffic safety is threatened and traffic flow is reduced leading to forms of congestion. Cycling trails exceed the carrying capacity when there are not enough of them and when they are not considered safe enough or properly indicated. Economic indicators, however, are exceeded when there is a shortage of beds and it is necessary to redirect guests to other destinations.

Table 1 shows the estimated numerical value of the indicators (1–9), the assessment of the carrying capacity of the indicators (unused, not exceeded and exceeded) and the proposals for increasing the carrying capacity of the destination (municipality). Data for the assessment of each indicator were taken from available databases for the period 2011–2020 (Environmental atlas of Slovenia, Spatial information systems of municipalities (PISO), municipal development plans, Slovenian Infrastructure Agency and Statistical Office of the Republic of Slovenia) and from the information obtained through personal communications with tourism managers in the municipalities in question, where they highlighted trends in tourism and problems which are generally similar in nature for all three municipalities. Below, we have justified a certain value of the carrying capacity for each indicator. In order to improve the exceeded carrying capacity in the future or to prevent exceeding the carrying capacity at indicators that have not yet been exceeded, we have developed proposals to increase the carrying capacity in question.

3 Assessment of the carrying capacity for tourism in the municipalities of Tolmin, Kobarid and Komen

In assessing the carrying capacity for tourism in the municipalities of Tolmin, Kobarid and Komen, we have selected and here discuss nine indicators for which we argue they play an important role and will therefore provide us with the best overall assessment of the carrying capacity of each municipality for tourism.

We assessed that the best indicator in the group of spatial-ecological indicators was the surface water quality of the Soča river basin. On the basis of favourable results derived from extensive analyses and continuous monitoring undertaken by the Institute for Waters of the Republic of Slovenia, we assessed its current status as 'unused' giving the municipality of Tolmin a value of 3. Based on the bathing water data provided by the Slovenian Environment Agency, it was found that the river Nadiža, in the Kobarid municipality, is the river most below the threshold of carrying capacity and we therefore gave this one a value of 2. The carrying capacity of the water quality is unused but we do not want to load this indicator any further. In order to maintain surface water quality adequately in the Soča and Nadiža river basins, it is necessary to continue to build appropriate wastewater discharge and treatment systems in Tolmin and Kobarid, to limit the use of the coastal zone, to regulate the discharge of all storm water as well as to prevent all illegal discharges and to take appropriate care of the river itself and the area along it with various actions to be undertaken by local residents. Due to the absence of surface water on the Karst, protected natural areas of Natura 2000 were selected in the Komen municipality. The preserved karst nature of the landscape is one of the main motives for visiting the entire Karst region. When examining the indicator for the protected natural area of Natura 2000 in Komen, we found that this indicator has not been exceeded. Numerous projects in the field of biodiversity experience, education, workshops and festivals have been undertaken, or are in the process of being undertaken, which shows that the attitude of local residents towards protecting the natural environment is positive (with the renovation of ponds, regulating paths, with a planned establishment of a Geopark with an information and education centre). The number of tourism providers included in Slovenian Tourism's Green Scheme, - Slovenia Green, is also on the increase.

Table 1: Assessment of carrying capacity indicators for the Tolmin, Kobarid and Komen municipalities.

Type and selected indicators	Estimated indicator value and CC rating	Proposals to increase the carrying capacity
Spatial-environmental		
Quality of surface waters in the Soča river basin/ Natura 2000	Tolmin 3 unused Kobarid: 2 unused Komen: 5 not exceeded	Tolmin, Kobarid, Komen: construction of treatment plants; increase control of pollutants, activities in the area and water quality; prevention of illegal discharges; cleaning campaigns; raise visitor awareness of the vulnerability of the area. Komen: establishment of the Karst Geopark.
Collection and treatment of waste	Tolmin: 5 not exceeded Kobarid: 5 not exceeded Komen: 4 not exceeded	Tolmin, Kobarid, Komen: follow waste management trends; adequately inform local residents and tourists about waste sorting (stickers, brochures and whiteboards - also in foreign languages); to provide more waste bins in those areas where there are a greater number of tourists and at mass events; to empty waste bins regularly. Tolmin, Kobarid: to increase controls on illegal camping.
Supply and consumption of potable water	Tolmin: 5 not exceeded Kobarid: 5 not exceeded Komen: 5 not exceeded	Tolmin, Kobarid, Komen: raise awareness and inform the local population and visitors about the vulnerability of water resources; encourage the collection of rainwater; use treated water from treatment plants for irrigation, cleaning roads etc.; promote green business and self-supply of potable water; control the consumption and quality of potable water.
Infrastructure		
Parking spaces	Tolmin: 9 exceeded Kobarid: 9 exceeded Komen: 8 exceeded	Tolmin, Kobarid, Komen: to provide information boards; construct additional parking lots; introduce parking fees or time-limited free parking; provide parking lots for larger vehicles; promote sustainable forms of transport and public transport; establish appropriate signage; provide stewards at planned events.

Length of renovated local and national roads	Tolmin: 8 exceeded Kobarid: 7 exceeded Komen: 7 exceeded	Tolmin, Kobarid, Komen: to renovate roads faster; put warning signs at dangerous sections and establish road sharing (including cyclists); increase traffic safety.
Cycling trails	Tolmin: 9 exceeded Kobarid: 9 exceeded Komen: 7 exceeded	Tolmin, Kobarid, Komen: expand cycling trails; provide adequate signalling; regulate infrastructure properly in respect of cycling trails (provide parking spaces for bicycles, bicycle services, bicycle-friendly accommodation and increase availability of public transport for bicycles); exploit the exceptional potential for cycling tourism.
Economy		
The number of nights	Tolmin: 6 exceeded Kobarid: 7 exceeded Komen: 8 exceeded	Tolmin, Kobarid, Komen: increase the quality of existing capacities and consequently increase the prices and manage tourist visits; offer new services in order to deseasonalise tourist visits; extend the length of tourist stays outside the season; control the registration of guests and payments for using general infrastructure services. Tolmin, Kobarid: prevent illegal camping.
The number of tourists	Tolmin: 6 exceeded Kobarid: 8 exceeded Komen: 6 exceeded	Tolmin, Kobarid, Komen: expand existing general and tourist infrastructure; control the registration of guests and payments for using general infrastructure services; increase the quality of services and the consequent increase in prices; Establish admission fees for tourist attractions; Expand offers across the whole municipality.
The number of accommodation facilities	Tolmin: 7 exceeded Kobarid: 6 exceeded Komen: 7 exceeded	Tolmin, Kobarid, Komen: provide incentives for investors to invest in additional accommodation facilities (smaller hotels, dispersed hotels, glamping, tourist farms and eco accommodation); raise the quality and prices of services to match demand with available facilities.

When examining the indicator for waste collection and treatment, we found that the Tolmin municipality was exemplary in this area. The amount of waste increased by 45% in the period 2012–2019, although it decreased in 2020, but at the expense of fewer tourist visits due to the Covid-19 pandemic, so its carrying capacity was allocated a value of 5. Therefore, the amount of waste in 2019 was the highest it has been in the last ten years at 462 kg/inhabitant, according to the data on collected waste 2011–2020 provided by the Statistical Office of the Republic of Slovenia (Table 2). As the volume of waste also increases in relation to the increase in the number of tourists, raising awareness must be targeted, not only at the local population but also at tourists. We have found that the collection and treatment of waste in the municipality of Kobarid is exemplary. As the number of overnight stays made by tourists in Kobarid increases, the amount of collected waste will also rise. Waste management will also improve due to adequate information on the number of tourists at a certain destination, so the recording and reporting of this information must be regulated. According to the data obtained, the indicator for the collection and treatment of waste was assessed to have a value of 5 as the indicator has not been exceeded. Although the amount of waste has been increasing in recent years, the municipality is following trends in the field of waste collection and treatment, and is also raising awareness of trends and waste collection among the local population and tourists.

For the municipality of Komen, in the group relating to spatial-ecological indicators, the indicator for the collection and waste treatment was assessed as best, with a score of 4, so consequently it did not exceed its margin. We noticed that the increased number of nights and events did not affect this indicator which we would like to see continue in the future. In order to maintain this factor, we would like to see greater promotion of Komen as a green destination, with information material published in foreign languages etc.

The indicator for potable water supply and consumption in all three municipalities was assessed as a five, an indicator showing that it has not been exceeded. This is justified by the fact that there is enough water in these municipalities, and the supply provided by Tolmin's public services for Tolmin and Kobarid and the Karst water supply in Komen are also considered adequate. Water consumption in Tolmin, Kobarid and Komen is fairly stable, which is encouraging (Hvala 2018; Baša 2020; Volarič 2020). According to the data provided by Tolmin's public services for the years 2014–2019 for the municipality of Tolmin, the volume of water sold increased by 0.8%, and in Kobarid by 8.5%. According to the data provided by the Sežana Karst Water Board for the period 2008–2018 covering the municipality of Komen, the volume of water sold increased by 0.5%. As the number of overnight stays increases, the consumption of potable water will also increase, so we need to handle water supplies as carefully as possible in the future, as there are no natural water collection areas on the Karst, and groundwater sources are very vulnerable. It is necessary to act sustainably and to reduce water consumption per capita and per tourist overnight stays with appropriate measures. We propose to raise awareness among the local population and tourists about the impact of climate change on the supply of potable water and to fight against climate change. It is important to promote the use of recycled water and the collection of rainwater in order to avoid a shortage of potable water in the future.

Table 2: Municipal waste generated, collected and disposed of (kg per capita) in Tolmin, Kobarid and Komen from 2011 to 2020.

Year	Municipal waste generated (kg per capita)			Municipal waste collected by public collection (kg per capita)			Municipal Waste Disposed (kg per capita)		
	Tolmin	Kobarid	Komen	Tolmin	Kobarid	Komen	Tolmin	Kobarid	Komen
2011	–	–	–	315	346	227	210	224	116
2012	317	346	246	282	311	211	163	178	105
2013	368	399	404	274	305	310	84	16	132
2014	399	427	340	288	316	229	77	83	84
2015	430	454	359	295	318	224	181	263	76
2016	402	455	376	273	326	292	–	–	–
2017	442	498	367	303	359	227	0	–	11
2018	449	505	374	315	371	240	14	18	11
2019	462	537	382	311	386	231	66	0	3
2020	318	398	364	294	369	341	33	8	2

The parking space indicator was assessed to have been an exceeded indicator in all three municipalities. Most parking spaces in the Tolmin municipality are allocated for shops such as Hofer, Eurospin and Mercator. In 2018, 593 parking spaces were available in Tolmin (Hvala 2018). In addition to the larger towns in the municipality (Tolmin, Most na Soči and Podbrdo), there is a shortage of parking spaces at the most visited spots in the municipality (Tolmin Gorge and the Church of the Holy Spirit in Javorca). It was concluded that this problem needs to be addressed from a broad perspective as it is linked to the construction of the by-pass and is the result of weak infrastructure for cyclists and pedestrians. The indicator for parking spaces in Tolmin and Kobarid was assessed to have a value of 9 and therefore an exceeded indicator. There are not enough parking spaces in Kobarid during the tourist season. There were 268 recorded parking spaces provided in Kobarid in 2020 (Volarič 2020). According to the inter-municipal chief administrator, the greatest shortage of parking spaces were noted in Kobarid and at the more popular tourist destinations throughout the municipality (accessible points to the bathing areas along the Nadiža and the Soča rivers). Since 2016, Hop-On Hop-Off bus transport has been organised in the municipality of Kobarid, connecting the countryside, remote tourist points, bathing areas along the Nadiža and starting points for hiking and cycle routes to the heart of Kobarid. In the municipality of Tolmin there is a bus service to the Tolmin Gorge and to the Church of the Holy Spirit in Javorca, which has somewhat relieved road congestion and the pressure on parking spaces. Looking forwards, action will have to be taken to tackle this problem, as some visitors park in private parking spaces and privately owned land as well as along roadsides, where passage is already very limited (Figure 1). The indicator for parking spaces for the municipality of Komen was assessed to have a value of 8 and is therefore an exceeded indicator, as we believe that there are not enough parking spaces with respect to its needs.

We assessed the indicator for the length of renovated local and state roads to have a value 8. Due to the high construction costs associated with the complexity of the terrain, renovation works in the Tolmin

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Figure 1: Crowded parking area at the entrance to the Tolmin Gorge in July 2019.

area are slow. Road infrastructure needs to be improved, and as much as possible should be done to improve the safety of all road users. The indicator for the length of renovated local and state roads for the municipality of Kobarid was deemed to have a value of 7, therefore the indicator has been exceeded. Road infrastructure in the Kobarid area is slowly improving, and it should continue to improve. In future, dangerous road sections should be properly regulated in order to increase safety. The indicator for the length of renovated local and state roads was also assessed to have a value of 7 for the municipality of Komen. Reconstruction works on local and state roads were mostly undertaken in the years before 2014, and not one local road has been renovated since then, regardless of the fact that there are many dangerous, narrow sections through certain villages, in Komen, Gorjansko, Štanjel, Ivanji Grad, Škrbina and Brje pri Komnu for example.

For the municipalities of Tolmin and Kobarid, the indicator for cycle trails was assessed to have a value of 9, and therefore it has an exceeded indicator, because there are insufficient or hardly any designated cycle trails. In both municipalities, cyclists mainly use the existing road network. The cycle trail was allocated an indicator value of 7 for the municipality of Komen as there are no designated cycle trails in the municipality, and the accompanying infrastructure network is also insufficient. In addition to a better network of cycle trails, the system for automated bike rental »Bike Sharing on the Karst« within the framework of the Interreg project, CROSSMOBY (Figure 2), free bus transport of bicycles in the summer from Slovenian Istria to Karst on the »KoloBus« and on the route between Štanjel and Devin, have also contributed to a better indicator value for the municipality of Komen compared to those of Tolmin and Kobarid. In all three municipalities, it is necessary to expand the existing cycle trails and arrange appropriate signage and infrastructure (bicycle parking spaces, bicycle service, cyclist-friendly accommodation, adjusted offers and an increased availability of public transport). It is necessary to make better use of the exceptional potential for cycle tourism, which all three municipalities have owing to their rich natural and cultural heritage.

RRC KOPER/INTERREG IT-SI CROSSMOBY

Figure 2: Electric bicycle rental system in Štanjel.

Regarding economic indicators, i.e. the number of tourists, the number of overnight stays and the number of accommodation facilities according to the 2011–2020 data provided by the Statistical Office of the Republic of Slovenia (Tables 3–5), we found that all indicators are exceeded at the peak of the summer season in all three municipalities. The number of overnight stays increased significantly in the period 2011–2019, namely in the municipalities of Kobarid by 108%, Tolmin by 269% and Komen by 149%. During the same period, the number of overnight stays in Slovenia increased by 51%. In the period 2011–2019, the number of beds increased in Kobarid by 81%, in Tolmin by 398% and in Komen by 75%. In all three municipalities, there is a shortage of accommodation facilities during the summer season. All three destinations generally offer accommodation with smaller capacities: in the municipalities of Tolmin and Komen there are private rooms and apartments, and in Kobarid there are also campsites. Everywhere, however, there is a shortage of smaller hotels to accommodate larger coach parties who arrive by bus to their destination and have to be directed to other municipalities. It is therefore necessary to encourage investors to invest in additional accommodation facilities to establish a structural balance (smaller hotels, dispersed hotels, glamping, tourist farms and eco- accommodations). Improved quality and consequently higher prices can contribute to the management of mass tourism. It is necessary to create new tourist products in order to deseasonalise tourism and to prolong the length of stay of tourists outside the season. If registration was better controlled in respect of guests and payment for the use of general infrastructure services and if illegal camping was prevented, especially in the municipalities of Tolmin and Kobarid, more efficient destination management would be possible.

With the aid of nine selected indicators, we found that the best assessment of the carrying capacity was given for spatial and ecological indicators: the quality of surface water in the Soča river basin, in the case of the Posočje municipalities of Tolmin and Kobarid, and the protected natural areas in the case of the Karst municipality of Komen, with its collection and treatment of waste and the supply and consumption of potable water.

Infrastructure indicators have proved to be the weakest aspect with all the groups, so municipalities will need to ensure there is a rapid improvement of the infrastructure if they want to continue to develop as successful and sustainable tourist destinations. Improvements are needed both in the field of tourism infrastructure and general infrastructure. All three indicators, i.e. parking spaces, the length of renovated local and state roads and cycle trails were assessed as having exceeded their margins. In addition to expanding and providing adequate infrastructure, municipalities can also improve when it comes to learning from

Table 3: Number of beds in the municipalities of Tolmin, Kobarid and Komen from 2011 to 2020.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Kobarid	1968	2045	1986	2050	2303	2337	2376	–	3564	4116
Tolmin	1427	1491	1788	1892	1869	1980	2279	–	7106	4087
Komen	167	175	151	175	165	142	190	–	293	–

Table 4: Number of tourists in the municipalities of Tolmin, Kobarid and Komen from 2011 to 2020.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Kobarid	38,368	37,744	37,051	33,137	42,248	44,227	54,487	67,698	79,915	57,513
Tolmin	14,225	15,773	20,723	21,521	25,939	29,034	36,093	56,446	61,809	44,142
Komen	1660	1585	1675	2027	2146	2326	3565	4787	5220	–

Table 5: Number of overnight stays in the municipalities of Tolmin, Kobarid and Komen from 2011 to 2020.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Kobarid	97,350	99,249	97,457	83,964	103,731	110,909	141,295	186,187	202,297	158,011
Tolmin	43,652	48,719	59,694	65,601	75,653	80,954	101,039	157,852	161,160	119,228
Komen	4439	4130	5435	4882	4582	4748	6515	10,968	11,051	–

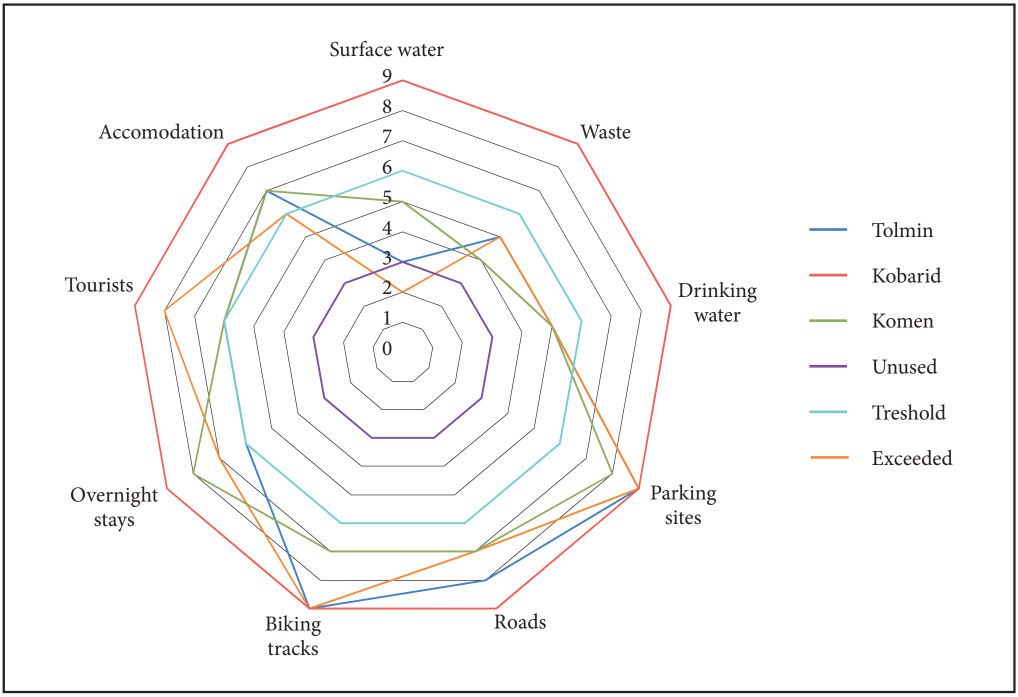

Figure 3: Carrying capacity of the municipalities of Tolmin, Kobarid and Komen.

other cases of good practice at home and abroad in the area of introducing sustainable mobility. It is also necessary to monitor spatial-ecological indicators that have not exceeded margins and to maintain their favourable status and to make even better use of the potential of the available unused surface water in the Soča River basin.

4 Discussion

This research represents an important contribution to testing the comprehensive assessment method on the carrying capacity for tourism. It differs from partial assessments of carrying capacity, where spatial-environmental or socio-cultural carrying capacities for beaches (Tselentis, Prokopiou and Toanoglou 2006; Tselentis et al. 2006; Zacarias et al. 2011; Corbau et al. 2019) and destinations (Manning 1999; Mavri 2018a, 2018b; Jurinčič 2020) of natural and cultural heritage were analysed (Bertocchi et al. 2020; Camati et al. 2020; Bertocchi, Camatti and van der Borg 2021). In our case, in contrast to the methodology designed by UNEP and World Tourism Organization (Klarić et al. 2003) and the EU (Coccossis, Mexa and Collovini 2002) we divided the group of spatial-environmental indicators into two groups, namely spatial-environmental and infrastructural, covering the general infrastructure. We found that infrastructure indicators play a key role in assessing the carrying capacity for tourism. Also, in other tourist-developed countries (Klarić et al. 2003; Klarič and Marković 2013), it is evident that infrastructure indicators are the most critical group in further ensuring the sustainable development of tourism. When Soča Valley acquired the Gold Label award as a Slovenia Green Destination, an area which includes the municipalities of Tolmin and Kobarid, and Karst–Brkini, which also includes the municipality of Komen, the results were similar. Otherwise, ratings were lowest in the field of infrastructure (7 out of 10), which enables effective protection of the environment, such as waste and wastewater management, sustainable mobility and reduction of fossil fuels (ORA 2021). The implementation of the proposed measures to increase the carrying capacity of infrastructure indicators, which represent the weakest link, and to evaluate their effectiveness on an ongoing basis is essential for sustainable tourism development. Otherwise, the destinations in question will lose their gold labels awarded by the Slovenian Tourist Board's Green Scheme, which addresses all the pillars of sustainable tourism development and has an important promotional effect for the destinations of the Soča Valley and Karst–Brkini (Razpotnik Visković 2020).

Our findings regarding the exceeded carrying capacity of infrastructure and economic indicators were taken into account when developing new sustainable tourism development strategies for the municipalities of Tolmin and Kobarid within the destination area of the Soča Valley (Zupan et al. 2020) and for the municipality of Komen within the area of Kras-Brkini (Piciga, Prašnikar and Radić 2021).

If conditions change and with appropriate strategic management, the determined carrying capacity can be increased or reduced by imprudent behaviour or inadequate tourist development. This can happen in the future, for example, in the case of the potable water supply and consumption indicator, which currently has not exceeded its indicator in any of the municipalities in question.

Water consumption in tourism is becoming one of the key indicators of the carrying capacity of tourist destinations. With the increase in the number of overnight stays, the consumption of potable water will also increase as tourists are high consumers of water. One of the accommodation providers in Tolmin recorded a consumption of 398 litres of water per night (Hvala 2018), and an accommodation provider in the municipality of Kobarid reported 366 litres (Volarič 2020). Both are high and comparable to the water consumption at hotels in Slovenian Istria, where it averages 350 litres per night (Jurinčič and Bojnec 2009) and is significantly higher than the consumption of the local population, which in 2020, according to the data provided by the Statistical Office of the Republic of Slovenia, amounted to 159 litres per person and has been fairly stable for the last ten years. Climate changes must also be taken into account, which are also reflected in problems with a potable water supply (Cigale 2007; Scott 2021). Therefore, it is necessary to take appropriate measures to reduce the water consumption of residents and tourists (Baños Castiñeira and Viñals Blasco 2020), which also applies to the municipalities of Kobarid, Tolmin and Komen.

The method of using carrying capacity as a standard was very useful in practice when managing visits to natural and cultural heritage sites, and at municipal and regional level when preparing sustainable tourism development strategies. It also serves as an appropriate aid in adopting spatial planning strategies when locating tourism infrastructure in an area. In future, we believe it shall be possible to upgrade the carrying capacity method for tourism by using big data to monitor tourist visits in real time, which is already used in some UNESCO heritage destinations, such as Venice, Dubrovnik and the Dolomites (Bertocchi et al. 2020; Camatti et al. 2020; Bertocchi, Camatti and van der Borg 2021). With the aid of modern communication technology, we can also obtain more accurate data on day visitors and their movements and behaviour at a given destination. In this way, we could solve the problem of researching the carrying capacity where there is a lack of data regarding unregistered guests and one-day visitors, which is also a burden on the infrastructure.

The impact of the process of carrying capacity analysis on the local population, the tourist economy and the local administration is also very important. With their active involvement, this process can also educate and raise awareness of the importance of sustainable development. Sustainable development of tourism is possible in the long term only in cooperation with the local community, and it should be pointed out that it is necessary to involve local residents at an early stage of development and spatial planning (Nared et al. 2015; Gabrovec et al. 2017).

5 Conclusion

The carrying capacity method for tourism is an appropriate tool for promoting sustainable tourism and identifying limitations at a destination that must be taken into account in the context of further development. By carefully scrutinising individual indicators, we were able to determine whether their current carrying capacity had already been exceeded or not.

When exploring the carrying capacity for tourism in the municipalities of Tolmin, Kobarid and Komen, where tourism has increased significantly in the last decade, we found that the most problematic aspects are infrastructure and economic carrying capacity, and most factors have recorded excessive values during the summer season. The most favourable is the spatial-environmental carrying capacity, where no factor analysed had been exceeded.

The number of overnight stays in these municipalities had increased to above average in the period 2011–2019, both in relation to the average growth for the entire area of Slovenia (51%) and by the type of

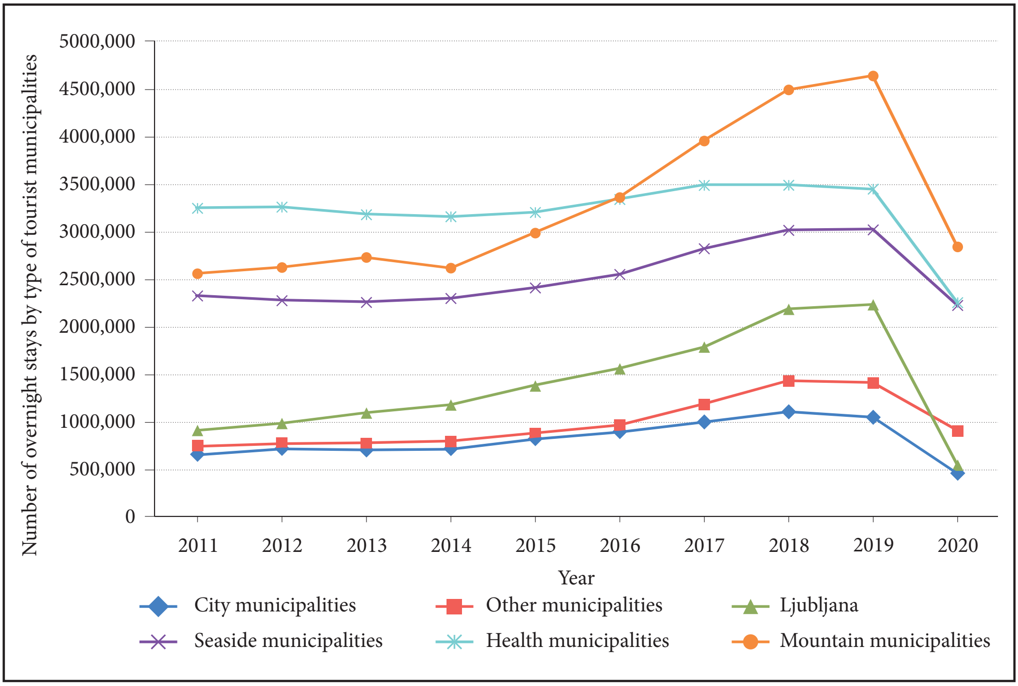

Figure 4: Number of overnight stays by type of tourist municipalities from 2011 to 2020.

tourist municipalities. The increase was 108% in the municipality of Kobarid, 269% in Tolmin, and 81% in the mountain municipalities. The growth of overnight stays in Komen (by 149%) also exceeds the average growth in other municipalities (92%) to which it belongs (Figure 4). There has been a more pronounced increase in the number of overnight stays in all municipalities since 2015 (Cigale 2019).

A record number of tourists who visited in the 2019 tourist season has highlighted the problem of overtourism, but this can be solved with appropriate management and the participation of all stakeholders. With the unexpected growth in the number of tourists visiting, we found that the municipalities are not adequately prepared for the increased growth in the tourism sector. Therefore, on the basis of the carrying capacities identified for various individual indicators, we have proposed measures to increase their carrying capacity or to maintain it at a level where it does not exceed in the future.

The results of the carrying capacity assessment for the municipalities in question for tourism should not be considered as a tool to severely restrict the development of tourism, but rather as an expert recommendation that will lead the development of tourism, in some areas, to another more sustainable direction or will transform it appropriately.

This research has some shortcomings, which in our opinion are outweighed by the contribution that has been generated by the otherwise partial subjective assessment. The analysis did not include all the factors which influence the assessment of the carrying capacity, but only nine key indicators that, we believe, are important when determining the capacity of the municipalities of Tolmin, Kobarid and Komen for tourism.

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Acta geographica Slovenica, 62-1, 2022, 105–124

REMOTE SENSING ANALYSIS TO MAP INTER-REGIONAL SPATIO-TEMPORAL VARIATIONS OF THE VEGETATION IN ICELAND DURING 2001–2018

Haraldur Olafsson, Iman Rousta

Figure: Single shrubs growing in grasslands in Hveragerði-Iceland.

DOI: https://doi.org/10.3986/AGS.10390
UDC: 581.9:551.583(491.1)»2001/2018«
COBISS: 1.01

Haraldur Olafsson[1,2,3], Iman Rousta[2,3,4]

Remote sensing analysis to map inter-regional spatio-temporal variations of the vegetation in Iceland during 2001–2018

ABSTRACT: Changes in the vegetation of the Arctic and sub-Arctic regions have been used as indicators of the impact and seriousness of climate change. In this study, 342 MODIS NDVI images were used to monitor and assess the variability and long-term changes in the vegetation in Iceland in the period 2001–2018. An insignificant trend in the changes of the vegetation coverage (R = 0.16, p-value = 0.05) was obtained, however, it also resulted that the area with the low values of the NDVI (< 0.6) is decreasing, whereas the area with higher values of the NDVI (> 0.6, mostly forests) is increasing. The NDVI index during the study period rose for the area of about 3260 km^2, while it declined for 1635 km^2. The results of this study can be used for organizing the strategies preventing climate change and global warming.

KEY WORDS: Iceland, vegetation dynamics, MODIS, NDVI, anomaly analysis

Kartiranje spreminjanja vegetacije v prostoru in času v različnih regijah na Islandiji med letoma 2001 in 2018 s pomočjo daljinskega zaznavanja

Spremembe v vegetaciji arktičnih in subarktičnih pokrajin so pokazatelj vpliva in pomembnosti podnebnih sprememb. V pričujoči raziskavi smo 342 posnetkov NDVI senzorja MODIS uporabili za spremljanje in oceno spremenljivosti vegetacije in njenih dolgoročnih sprememb na območje Islandije v obdobje 2001–2018. Ugotovili smo neznačilen trend spreminjanja pokrovnosti vegetacije (R = 0,16, p = 0,05), polega tega pa smo opazili, da se površina z nizkimi vrednostmi NDVI (< 0,6) zmanjšuje, površina z visokimi vrednostmi NDVI (> 0,6, predvsem gozdovi) pa povečuje. Indeks NDVI je porasel v opazovanem obdobju na območju 3260 km^2, zmanjšal pa se je na 1635 km^2. Rezultati študije so lahko uporabni za pripravo strategij preprečevanja podnebnih sprememb in globalnega segrevanja.

KLJUČNE BESEDE: Islandija, dinamika spreminjanja vegetacije, MODIS, NDVI, analiza anomalij

The article was submitted for publication on September 5th, 2021.
Uredništvo je prejelo prispevek 5. septembra 2021.

[1] University of Iceland, Department of Physics, Reykjavik, Iceland
haraldur@vedur.is (https://orcid.org/0000-0002-4181-0988)

[2] University of Iceland, Institute for Atmospheric Sciences-Weather and Climate, Reykjavik, Iceland
irousta@yazd.ac.ir (https://orcid.org/0000-0002-3694-6936)

[3] Icelandic Meteorological Office (IMO), Reykjavik, Iceland

[4] Yazd University, Department of Geography, Yazd, Iran

1 Introduction

Vegetation is an indispensable element of the Earth that links soil, air, water, and other components of the environment (Foley et al. 2000; Cui et al. 2009; Rousta et al. 2018; Rousta et al. 2020a; Mansourmoghaddam et al. 2021; Rousta et al. 2021). Environmental conditions and variability can define varaiety of future land cover (Zhang et al. 2019b; Shen et al. 2020; Wang et al. 2020; Chao et al. 2021). Vegetation dynamics carry valuable information about the impacts of global warming (Pettorelli et al. 2005; Olafsson and Rousta 2021), land degradation (Metternicht et al. 2010; Rousta et al. 2020c), and desertification (Symeonakis and Drake 2004; Rousta et al. 2020b). The Intergovernmental Panel on Climate Change (IPCC) highlights that the high northern latitudes are warming faster than other regions on the planet (Masson-Delmotte et al. 2018). As some researches point out, this is due to Polar Amplification (PA), a phenomenon in which effects such as decreasing sea ice and lower albedo due to reduced snow cover cause the Arctic temperatures to rise disproportionately under increased greenhouse gas emissions (Polyakov et al. 2003). The Arctic and sub-Arctic vegetation are highly sensitive to climate change, and the changes in the vegetation of this region have been used as indicators of the global impact of climate change.

With the advent of the space-borne era, using remote sensing and satellite images for assessment and monitoring of vegetation dynamics is common in research (Miao et al. 2018; Zhao et al. 2021a). Remotely sensed studies showed that since the 1980s the vegetation throughout northern latitudes has been increasing (Slayback et al. 2003; Bokhorst et al. 2009; Liu et al. 2015; Raynolds et al. 2015; Merrington 2019). One of the most widely used remotely-sensed indicators of vegetation is the Normalized Difference Vegetation Index (NDVI), which is highly sensitive to ecosystem conditions (Ollinger 2011; Lemenkova 2020a). NDVI is the normalized difference between the near-infrared (NIR) and visible red band's reflectance (Rouse et al. 1974; Tucker 1979) and has great potential for vegetation monitoring. The greater the NDVI value is, the higher is the photosynthetic capacity (Tucker 1979; Gao and Goetzt 1995; Chen and Brutsaert 1998). It can be used for detecting changes in vegetation development, such as downtrends or uptrends (Alcaraz-Segura et al. 2010; Ghafarian Malamiri et al. 2020). Over the last few decades, many scientists have established the effective role of NDVI on vegetation variability, or drought dynamics assessment, and monitoring of them (Kogan 1991; Kogan 1995; Yang et al. 1998; McVicar and Bierwirth 2001; Ji and Peters 2003; Wan, Wang and Li 2004; Zhao et al. 2021b). The AVHRR (Advanced Very High-Resolution Radiometer) derived NDVI is available since 1981, which creates an opportunity to monitor vegetation dynamics (VD) on various scales, from global or country to small regions, using time series data for different periods. The increased NDVI was found in peak parts of the Arctic, with the growth of the summer surface temperature believed to be the reason for this. In-situ measurements performed at various locations across the tundra biome during 1980–2010 have also connected the increases in sampled vegetation to summer warming (Elmendorf et al. 2012). The highest NDVI trends for the AVHRR record were observed for Iceland in the period 1982–2010 (0.008 NDVI units per year) (Epstein et al. 2012). Greenland, which was mentioned as the second with the highest increases, also had an increase of 0.005 NDVI units per year, and the rest of the northern countries experienced increases equal to 0.003 per year or less (Epstein et al. 2012). Additionally, the NDVI has decreased in certain areas, in which reduction of air temperature occurred (Bhatt et al. 2013). For example, in parts of Scandinavia, recent decreases in NDVI have been linked to winter warming events that reduced the protective snow layer (Bokhorst et al. 2009) and to unfavorable summer conditions and insect outbreaks (Bjerke et al. 2014).

Soil is an important factor that influences the processes between the land surface and atmosphere (Zhang et al. 2019a; Zhao et al. 2020; Zuo et al. 2020; Li et al. 2021; Li et al. 2022; Miao et al. 2022). In terms of world ecosystems, Iceland is unique, mostly because of its soils. The island's geology is overwhelmingly influenced by relatively recent extrusive volcanism, which forms the main parent material for its soils. On a geologic timescale, soil formation occurred about 10,000 years ago, which coincides with the end of the last glacial period (Arnalds et al. 1995). The basaltic tephra, which is the term for material of any size ejected by volcanoes, is one of the parent materials of soil types in Iceland (James, Chester and Duncan 2000; Arnalds 2008). The land-cover of Iceland is very dynamic. Erupting volcanoes produce lava flows and ash deposits, which dramatically transform landscapes. Despite the low population density (3.1 inhabitants/km^2 in 2010), it's the human influence that affects most of the countryside (Jóhannesson 2010) and its water surrounding (Mansourmoghaddam et al. 2022). Within an Icelandic context, understanding biodiversity is of special importance, as Iceland has a landscape history of which has been characterized by frequent, energetic geological processes (Thorarinsson 1967) and pressure on its ecosystems due to the land-use changes imposed after Iceland was settled by humans (Dugmore et al. 2009; Sigurmundsson et al. 2014; Bates et al. 2021). This has led to relatively low biodiversity in Iceland compared to the lands at similar latitudes (Jóhannesdóttir et al. 2017). The reduction in vegetation cover in Iceland in historical times has resulted in feedback loop. With less vegetation present to bind the soil, it becomes vulnerable to aeolian processes (Arnalds et al. 2001). This wind erosion removes useful surface nutrients, making vegetation colonization problematic (Óskarsson et al. 2004). It is reported that these processes have left large areas of Iceland barren (Arnalds et al. 2001).

In the sense of environmental sustainability, Iceland is subject to volcanic eruptions, local overgrazing, and soil erosion. Most of the vegetation is located in the coastal zone and the human settlement areas. On the other hand, the Icelandic vegetation, same as it is with the sub-arctic and arctic vegetation, is of high importance for wild and human life. Studying vegetation dynamic and their link to climate change is therefore of high importance for securing the ecological sustainability of Iceland. However, studies that focus on Iceland are rare and almost none of them focused specifically on the assessment of the vegetation evolution for the whole Iceland during recent years. Therefore, the objective of this research is to assess the spatio-temporal NDVI variations in Iceland and its main sub-regions.

2 Material and methods

2.1 Study area and data collection

Iceland is located between 63 and 67°N, and 13 and 25°W. It is the second-largest island in the Northern Atlantic, having an area of 103,000 km^2 and a population of 360,000. More than two-thirds of the population live in Reykjavík city and surrounding areas in the southwestern part of the country. Reykjavík is the capital and the largest city of Iceland. The country is volcanically and geologically active and consists of highlands, glaciers, and mountains. Iceland is a mountainous island, yet it does not have areas with high elevations. About 26% area of Iceland lies between 0–200 m, 36% between 200–600 m, 17% between 600–800 m, and 21% above 800 m. The highest mountain is 2119 m (Thorsteinsson, Olafsson and Van Dyne 1971). The climate of the country is temperate and the archipelago lies in a tundra vegetation zone.

In the present study, the country was divided into 8 main regions. The South and East regions with 9421 and 7786 km^2 have the largest share of vegetation coverage and the South East Peninsula and Reykjavik area with 894.4 and 701.6 km^2 have the smallest share of Iceland's vegetation coverage (Table 1). The south coast is wetter, windier, and warmer than the north. The snowfall in winter is more common in the north than in the south. The climate of Iceland was described in detail by Einarsson (1984) and Ólafsson et al. (2007). While the country is close to the Arctic, the coastal area remains ice-free through the winter (Figure 1). The largest parts of Iceland are covered by grasslands (about 55%, 56,250 km^2), barren land (about 28%, 28,958 km^2), and permanent snow and ice cover (about 10%, 10,496 km^2) (Table 2).

Table 1: Basic characteristics of the main regions of Iceland.

Name	Area (km^2)	Vegetated area (km^2)	Nonvegetated area (km^2)	Vegetated area (%)	Max Elevation (m)	Average Elevation (m)
South (S)	24423	9421.7	15001.3	38.6	2015	513
Southwest Peninsula (SWP)	792	701.6	90.4	88.6	610	99
Reykjavik Area (RA)	1001	894.4	106.6	89.4	1050	219
West (W)	9346	6929.4	2416.6	74.1	1717	320
West Fjords (WF)	9038	4401.0	4637.0	48.7	1012	323
Northwest (NW)	12346	7148.9	5197.1	57.9	1796	494
Northeast (NE)	21712	6980.7	14731.3	32.2	2057	580
East (E)	22074	7786.8	14287.2	35.3	2076	606

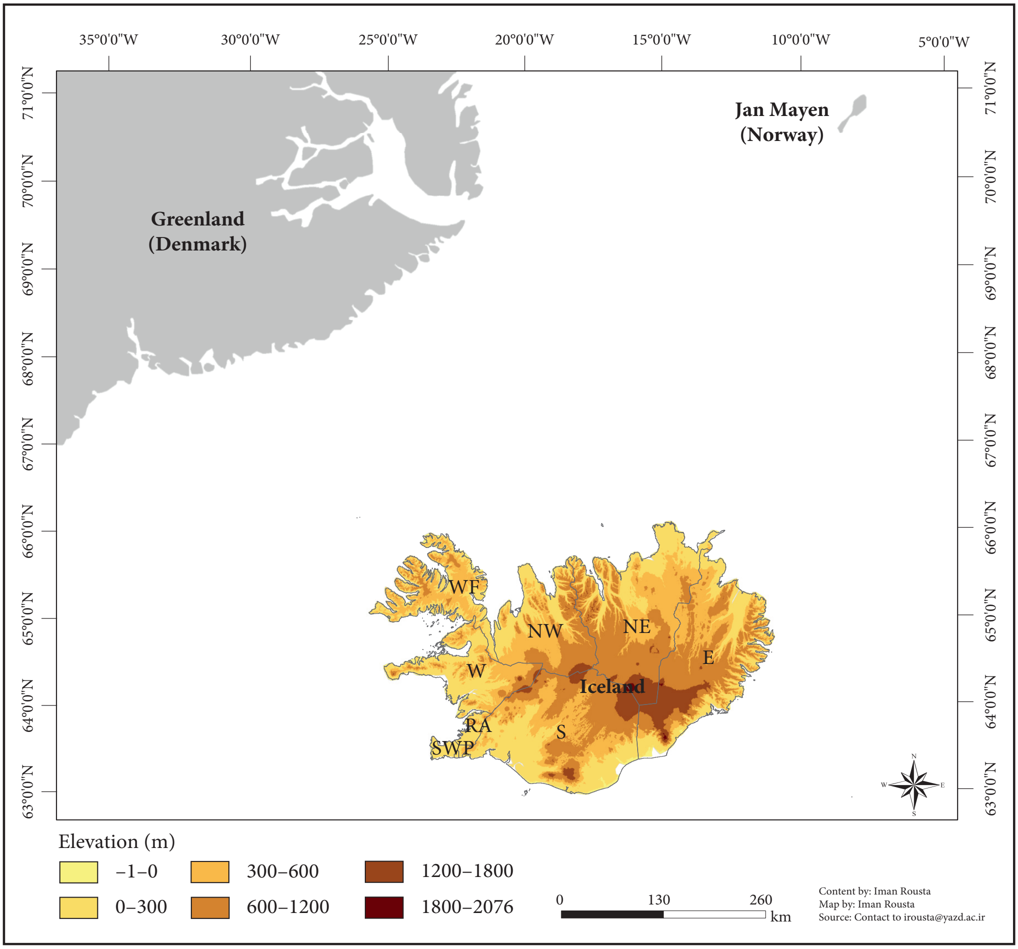

Figure 1: The map of the study area showing elevation and main regions.

Table 2: Iceland land cover types derived from MODIS (MCD12Q1) – Yearly Land Cover Type 1: Annual International Geosphere-Biosphere Programme (IGBP) (Loveland et al. 1999; Didan et al. 2015).

Land cover type	Area (km^2)	Percent of the whole area (%)
Evergreen Needleleaf Forests	9.7	0.009
Deciduous Needleleaf Forests	1.3	0.001
Deciduous Broadleaf Forests	4.8	0.005
Mixed Forests	6.1	0.006
Open Shrublands:	177.7	0.173
Woody Savannas	1.4	0.001
Savannas	2,953.5	2.867
Grasslands	56,255.2	54.617
Permanent Wetlands	1,823.0	1.770
Urban and Built-up Lands	47.9	0.046
Permanent Snow and Ice	10,496.5	10.191
Barren	28,960.8	28.117
Water Bodies	2,271.7	2.206
Total	103,000.00	100.000

2.2 Methods

To explore the spatio-temporal variability of vegetation coverage in Iceland, a total of 342 NDVI images were downloaded from the Terra MODIS vegetation Indices (MOD13Q1) database from the Land Processes Distributed Active Archive Center (https://lpdaacsvc.cr.usgs.gov.appeears) (Didan 2015a). The MODIS analysis-ready 16-day composite product (MOD13Q1.006) with 250 m spatial resolution was collected for the period from 1 January 2001 to 1 November 2018. ArcGIS 10.7 software and R environment were used to perform spatial and statistical analyses. The 1 arc-second (~30 m) spatial resolution SRTM (Shuttle Radar Topography Mission) elevation data was used to visualize the terrain profile of the study area (Zandbergen 2008).

NDVI is the most commonly used vegetation index (VI) for detecting the greenness of vegetation and production patterns (Tarpley, Schneider and Money 1984; Gitelson et al. 2003; Thenkabail, Gamage and Smakhtin 2004; Dutta et al. 2015). Scientists from all over the world have been using VI for investigation of various aspects of vegetation dynamic, i.e. vegetation mapping, monitoring, phonological analysis, crop growth, yields, and many more (Running et al. 1995; Moulin et al. 1997; Dabrowska-Zielinska et al. 2002; Geerken, Zaitchik and Evans 2005; Martínez and Gilabert 2009; Moniruzzaman et al. 2021). NDVI is defined as:

$$\mathrm{NDVI} = \frac{B^{nir} - B^{red}}{B^{nir} + B^{red}} \, . \tag{1}$$

The B^{nir} and B^{red} in Eq. 1 stands for the spectral reflectance in the near-infrared band and red band, respectively. NDVI ranges between −1 and +1, with the values from −1 to 0 indicating the absence of green leaves and the values from 0 to +1 indicating the greenest areas. Moderate NDVI values from 0.2 to 0.3 represent shrub and grassland, while high NDVI values (0.6 to 0.8) indicate dense vegetation (Montandon and Small 2008; Atasoy 2018; Jovanović, Milanović and Zorn 2018; Rousta et al. 2020b). NDVI values close to 0 represent the bare ground, while negative NDVI values correspond to water bodies snow and ice (Dye and Tucker 2003; Gandhi et al. 2015).

In the present research, the NDVI data were acquired from the Terra-MODIS Vegetation Indices MOD13Q1. To calculate the vegetation coverage, the number of pixels with vegetation, that is, having the NDVI m × 250 m = 0.0625 km^2). The same procedure was used for calculating the yearly and seasonal vegetation coverages. NDVI index was defined into 7 classes (0.2–0.3, 0.3–0.4, 0.4–0.5, 0.5–0.6, 0.6–0.7, 0.7–0.8 and > 0.8) for each of 8 selected regions separately, to calculate seasonal and annual vegetation coverages, along with inter-annual and inter-seasonal vegetation anomalies.

The annual and seasonal NDVI anomalies were calculated for each pixel during 2001–2018 as:

$$NDVI_{YA} = \frac{NDVI_y - NDVI_{\bar{y}}}{Std_y} \, , \tag{2}$$

$$NDVI_{SA} = \frac{NDVI_s - NDVI_{\bar{s}}}{Std_s} \, . \tag{3}$$

Where $NDVI_{YA}$ is a yearly anomaliy and $NDVI_{SA}$ is a seasonal anomaliy for each pixel in each year, $NDVI_s$ is the average NDVI for each season and $NDVI_y$ is the average NDVI for each year, $NDVI_{\bar{y}}$ is the average yearly NDVI for the whole study period 2001–2018, $NDVI_{\bar{s}}$ is the average seasonal NDVI for the whole study period 2001–2018, and is the standard deviation of NDVI for the whole study period 2001–2018, and is the standard deviation of NDVI for each season for the whole study period 2001–2018.

The study used a linear regression to define the correlations significant at a level of 0.05, which were taken into account in further analyses. Linear regression is a statistical method to find the relationship between two variables by fitting a linear model, in which one variable acts as an explanatory variable and the other one is a dependent variable (Song et al., 2005). A linear regression model is defined as:

$$y_i = a + bx_i \, , \tag{4}$$

where a and b are the regression coefficients. The b coefficient can be obtained from the given pairs of (x_i, y_i). In the current study regression model was used for calculating the trend of vegetation (as the dependent variable) during the years (as the independent variable) in Iceland during 2001–2018.

3 Results

3.1 NDVI variations

In Figure 2 the average vegetation coverage (NDVI > 0.2) in Iceland for the study period is shown. The NDVI is steadily rising from the midst of February, however, it is very slow till the middle of March (12,948 km^2). From the end of March, vegetation coverage starts to increase rapidly to reach 33,524 km^2 only one month later (at the end of April). The uptrend is continued in the next months and the maximum coverage is reached in the period from the middle of July to late August, having an average value of 66,858 km^2. After the end of August, the coverage of green vegetation decreases rapidly. Therefore, it can be stated that the average growing season (GS) in Iceland starts around 23rd March and ends at the end of August (Figure 2).

Figure 3 shows the time series of the annual average vegetation coverage in Iceland for the study period. There is an insignificant decreasing trend in the NDVI coverage for the study area in 2001–2018, however substantial interannual variability is also visible. In the years 2003, 2004, and 2017 the maxima in the annual average vegetation coverage were observed (being 43,229, 42,106, and 42,255 km^2, respectively), while in 2008, 2009, 2013, 2014, and 2015 the minima occurred (33,233, 33,962, 34,645, 34,051 and 34,398 km^2, respectively).

In Figure 4 the similar time series as in Figure 3 are shown, but for individual classes of the NDVI. There is a decreasing trend in the NDVI for the ranges between 0.2–0.5, and an increasing trend in the NDVI from the range of 0.6–1. However, no long-term trend for NDVI for the range 0.5–0.6 was observed (Figure 4 and Table 3).

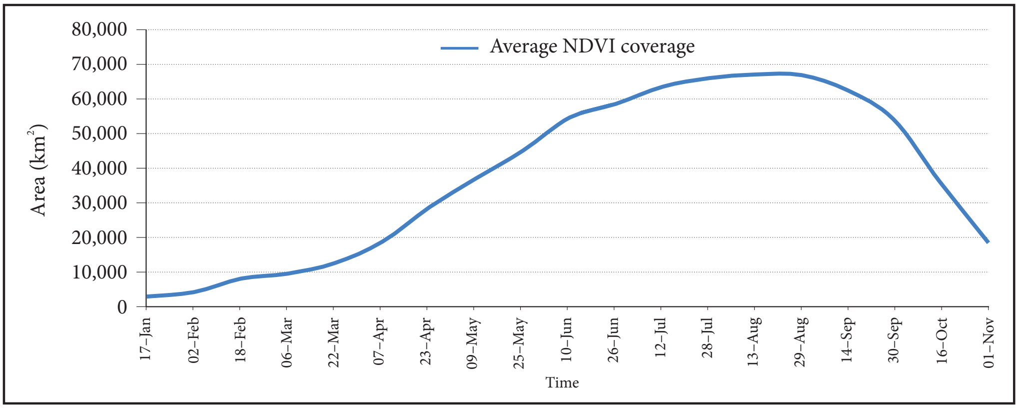

Figure 2: The average value of the NDVI coverage (> 2) in Iceland for the period 2001–2018.

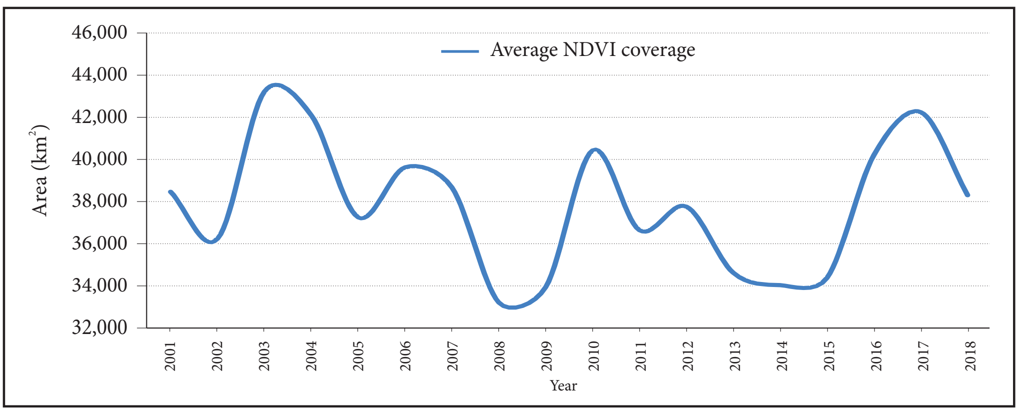

Figure 3: The time series of average annual vegetation coverage (NDVI > 0.2) in Iceland.

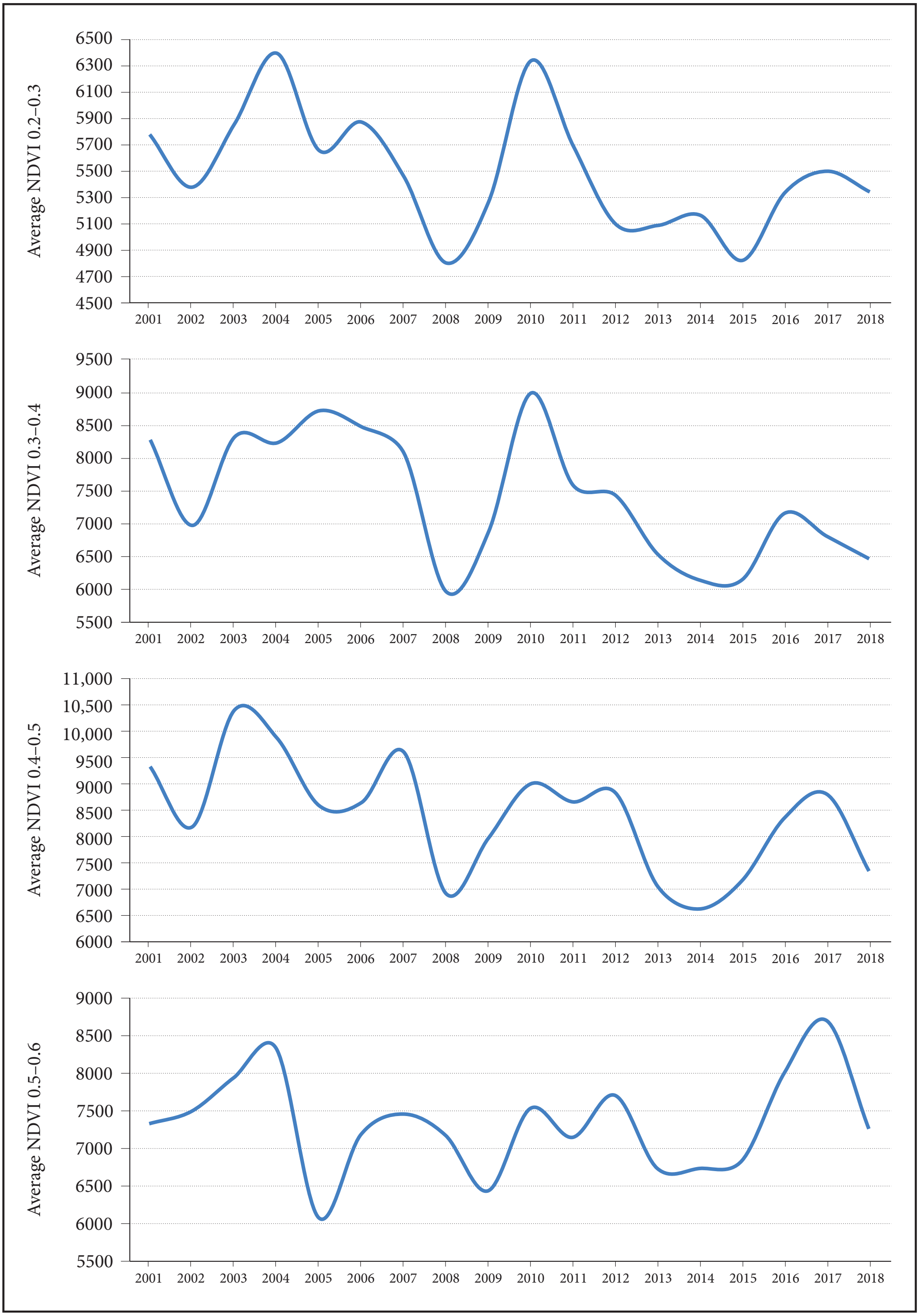

Figure 4: The time series of the average annual coverage of the vegetated areas with different ranges of NDVI values in Iceland. (p. 112–113)

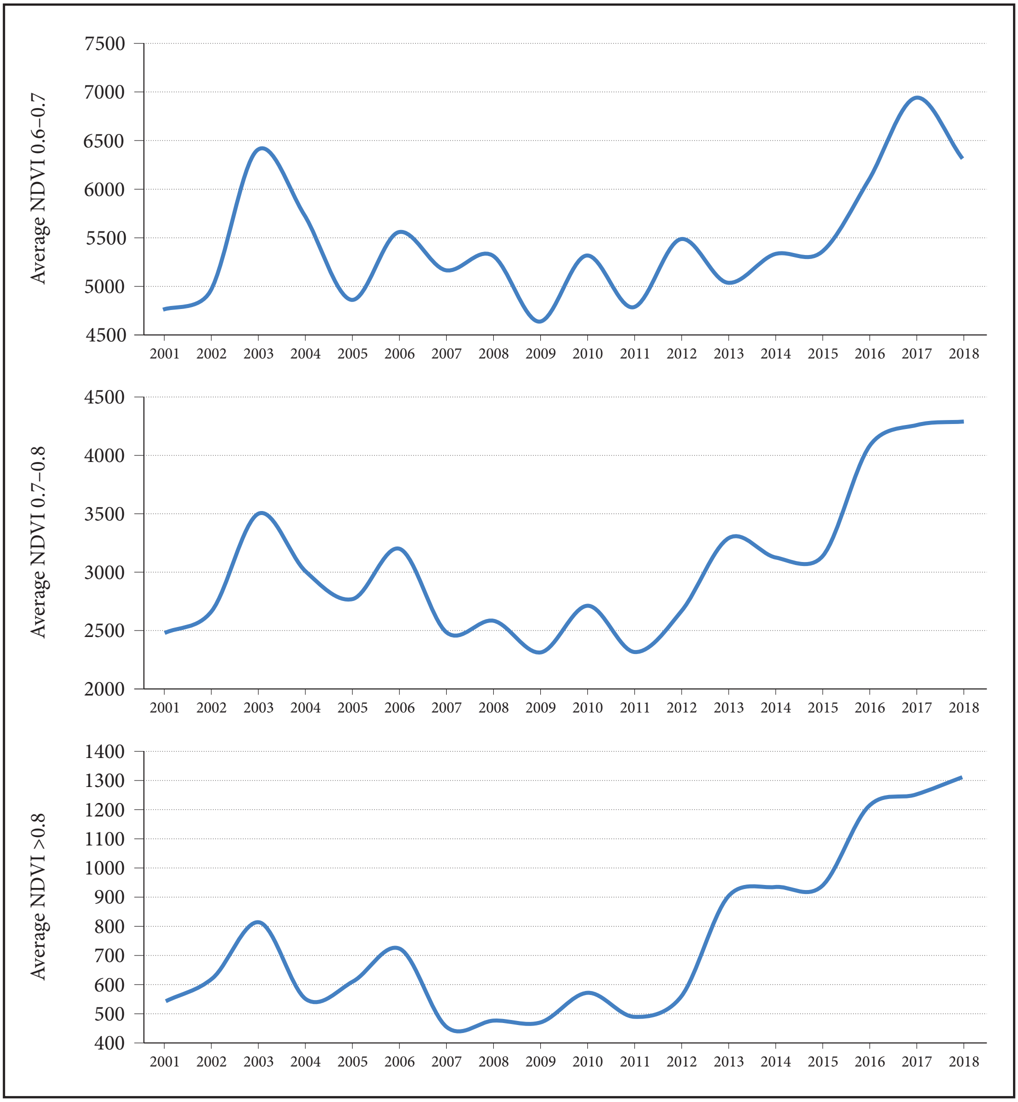

Table 3: The trend of different NDVI classes in Iceland in the period 2001–2018.

NDVI Categories	Correlation
Average NDVI 0.2–0.3	–0.46*
Average NDVI 0.3–0.4	–0.59*
Average NDVI 0.4–0.5	–0.55*
Average NDVI 0.5–0.6	0.05
Average NDVI 0.6–0.7	0.43
Average NDVI 0.7–0.8	0.59*
Average NDVI 0.8–0.9	0.70*
Average NDVI 0.9–1	0.80*

Note: * denotes significance at $p = 0.05$

3.2 Regional variability

Table 4 presents both the seasonal and annual percentage of area covered by vegetation in the regions of Iceland. The Southwest Peninsuls (SWP) and Rekjavik Area (RA) regions have the highest vegetation coverage, with an average annual value of 77.1 and 67.3%, respectively. The Northeast (NE) and East (E) regions have the lowest values, 26.9%, and 31.3%, respectively, followed closely by the South region with an annual value of only 33.6%. In winter very low percentage of the area is covered by vegetation, except in the Southwest peninsula. (Table 4 and Figure 5).

Table 4: The average seasonal and annual percentage of areas covered by vegetation (NDVI > 0.2) in the regions of Iceland in the period 2001–2018.

Period	S	SWP	RA	W	WF	NW	NE	E
Winter	2.2	36.8	4.5	2.8	0.0	0.1	0.2	1.6
Spring	31.5	85.1	78.2	60.5	23.6	40.2	16.7	17.9
Summer	53.6	94.0	95.5	92.1	77.4	80.9	51.3	57.4
Fall	47.1	92.5	90.8	83.5	61.5	66.7	39.3	48.2
Year	33.6	77.1	67.3	59.7	40.6	47.0	26.9	31.3

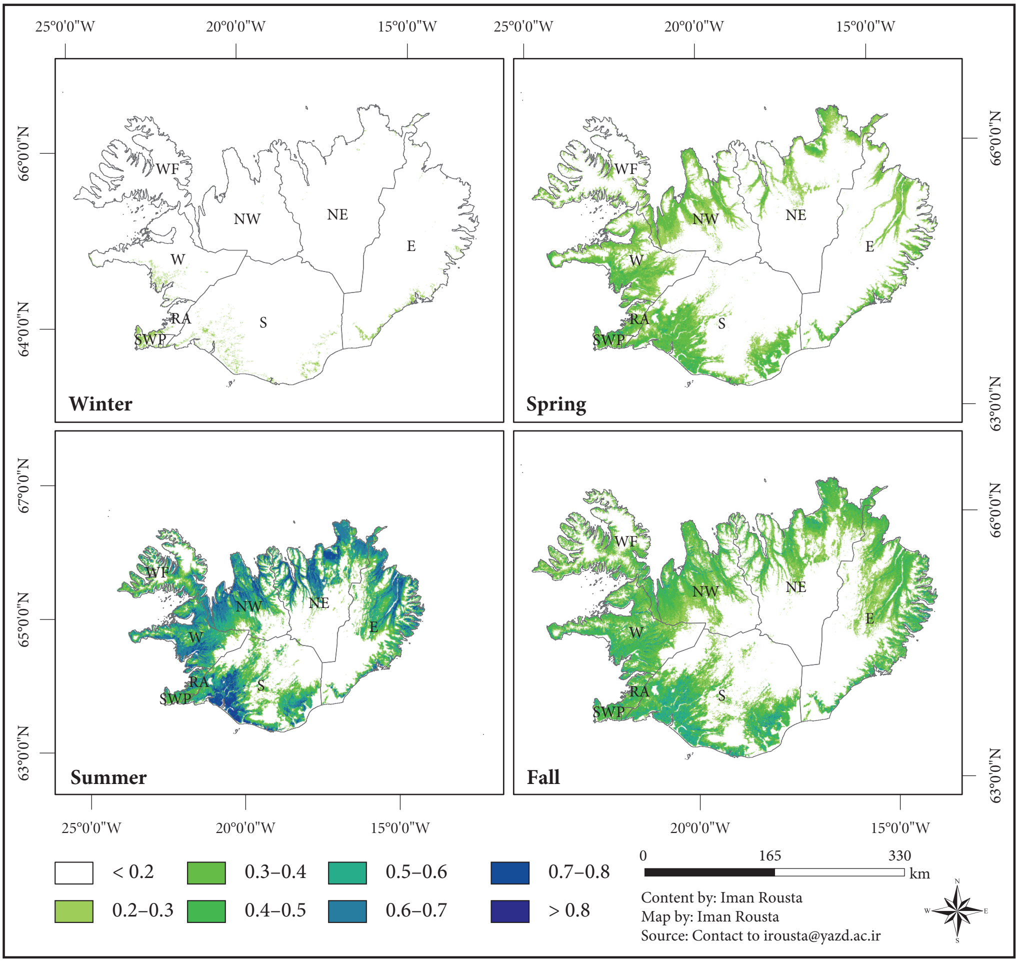

Figure 5: Average seasonal vegetation coverage in Iceland in the period 2001–2018.

In Table 5 information about the variability and trend of the NDVI during the study period for each of 8 regions of Iceland is provided. The highest average maximum NDVI values are found in the West, the South (0.66), and the East (0.63) regions. The lowest average maximum values are observed in the Northeast and Northwest (0.58) and the West Fjords (0.56). A small and insignificant downtrend in the maximum values in the East, and slightly higher, but also insignificant, uptrends in the Northeast, Reykjavik, Northwest, and West were found. A positive and statistically significant trend was found in the average maximum NDVI in the South. The average NDVI values represent mainly the proportion of mountains in the respective region, with the highest values observed for the Northeast, East, and West Fjords. The downtrends of average NDVI were observed for all the regions except the Southwest peninsula and the Northeast. The highest negative trend values were obtained for Reykjavik, the South, and the West regions, however, all of them were statistically non-significant. The standard deviation of the mean NDVI values is the smallest for Reykjavik and the Southwest Peninsula regions (about 0.1 std). The increasing trend of the standard deviation of the NDVI is significant in Reykjavik. Figure 6 shows the maximum annual NDVI for every region of Iceland for the whole study period (2001–2018). It was observed that the highest mean was in the South region (0.75), while the lowest was in the West Fjords (0.63).

Table 5: The descriptive NDVI statistics for the regions of Iceland for the period 2001–2018.

Name	Avg. Max NDVI	Avg. Max NDVI Trend	Avg. NDVI	Avg. NDVI Trend	Avg. Std NDVI	Avg. Std NDVI Trend
South	0.66	0.55*	0.20	–0.26	0.19	0.01
Southwest Peninsula	0.60	–0.08	0.34	0.07	0.10	0.24
Reykjavik Area	0.62	0.19	0.34	–0.21	0.10	0.58*
West	0.66	0.19	0.29	–0.22	0.14	0.50
West Fjords	0.56	–0.01	0.19	–0.13	0.14	0.00
Northwest	0.58	0.29	0.23	–0.14	0.15	0.14
Northeast	0.58	0.44	0.13	0.04	0.17	0.07
East	0.63	–0.14	0.15	–0.15	0.17	0.04

Note: * denotes significance at $p = 0.05$

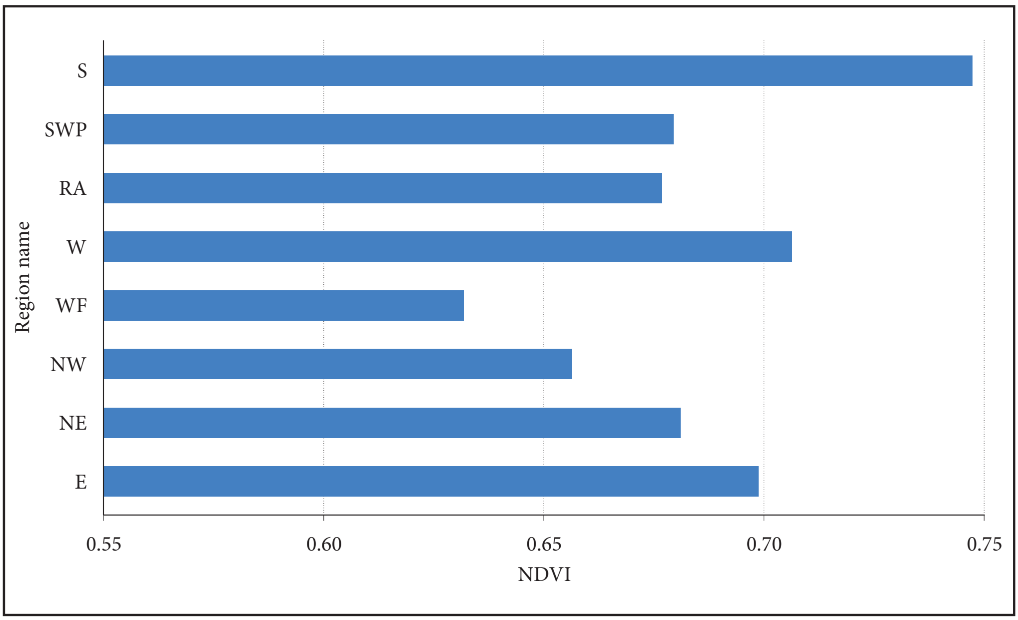

Figure 6: Maximum annual NDVI for the regions of Iceland for the period 2001–2018.

Assessment of the vegetation coverage trends in Iceland (Table 6) indicates that a reduction in NDVI in all regions was occurring in the winter season, however, it was significant only in Reykjavik (–0.5). It is worth noting that rather high values were observed also for the Northwest, West, and West Fjords regions (–0.4), but they were insignificant. In the spring, a negative non-significant trend occurred in most regions. In the summer, a strong and significant average NDVI uptrend can be noticed in the Southwest peninsula, while in other regions much weaker and non-significant trends occurred. In the fall, positive non-significant trends in the West, Northwest, and the West fjords can be noticed, while in other regions only minor changes occurred.

Table 6: Trends of the seasonal average NDVI values in regions of Iceland in the period 2001–2018.

Season	S	SWP	RA	W	WF	NW	NE	E
Winter	–0.3	–0.3	–0.5*	–0.4	–0.4	–0.4	–0.2	–0.2
Spring	–0.3	–0.1	–0.3	–0.2	–0.2	–0.2	0.0	–0.2
Summer	0.2	0.5*	–0.3	–0.1	–0.1	0.0	0.2	–0.1
Fall	0.1	0.2	–0.1	0.2	0.3	0.0	0.1	0.1

Note: * denotes significance at $p = 0.05$

Table 7 shows the percentage of the area with decreasing (change from –0.12 to –0.007 NDVI/year), stable (from –0.007 to 0.005 NDVI/year), or increasing (from 0.005 to 0.08 NDVI/year) values of the NDVI index for each region in Iceland during the study period. In all regions, no constant change of vegetation was observed on more than 80% of the lands. The WF and E regions had the highest share of land with a decrease of the vegetation (2.8 and 1.8%, respectively), while the remaining regions had smaller fractions of the area, on which vegetation decreased. At the same time, the WF and E were also the regions having the largest share of the area with increasing vegetation (5.6 and 3.7%, respectively), while in the remaining regions vegetation index rose on about 2–3% of the area. In general, an increase in the NDVI index was observed on about 3260 km^2, whereas a decrease on 1635 km^2 (Table 7 and Figure 7).

Table 7: The percentage of the area with decreasing, stable, or increasing vegetation of each region in Iceland during 2001–2018.

Trend (NDVI/year)	S	SWP	RA	W	WF	NW	NE	E
from –0.12 to –0.02 (Strong decrease)	0.2	0.0	0.1	0.1	0.2	0.1	0.1	0.2
from –0.02 to –0.007 (Decrease)	1.5	0.5	1.2	1.3	2.6	1.0	1.0	1.6
from –0.007 to –0.002 (No change)	8.1	3.3	7.3	6.6	12.3	5.6	6.9	9.4
from –0.002 to 0.005 (No change)	87.4	94.9	88.2	88.9	79.3	90.8	89.6	85.0
from 0.005 to 0.08 (Increase)	2.8	1.3	3.2	3.1	5.6	2.4	2.5	3.7

3.3 Location of the areas with the most extreme changes

Several areas with relatively large changes in the annual average of the NDVI index have been detected. Such areas appear as small clusters of pixels with a uniform color. In Figure 7 three additional locations relative to pre-2013 locations indicated by Raynolds et al. (2015) were marked by the boxes. The first one is located along the shorelines of artificial lake Hálslón in eastern Iceland (Figure 7, box a). The lake began to be filled in the fall of 2006 and due to variability of the lake water level, a reduction in vegetation along its shoreline was observed (Aradóttir et al. 2013). A second location is the extended riverbed of Skaftá River (Figure 7, box b). The river flooded in the fall of 2015 and for the second time in the summer of 2018, causing a substantial level of destruction of vegetation (Óskarsdóttir 2016). The third one is a landslide in Hítardalur, in western Iceland, which is covering about 2 km^2, including a small lake that was formed due to a dammed river (Dabiri et al. 2019). Although the landslide fell as late as at the end of the study period, in July 2018, it appeared in Figure 7 (box c) as a cluster of pixels with a downtrend.

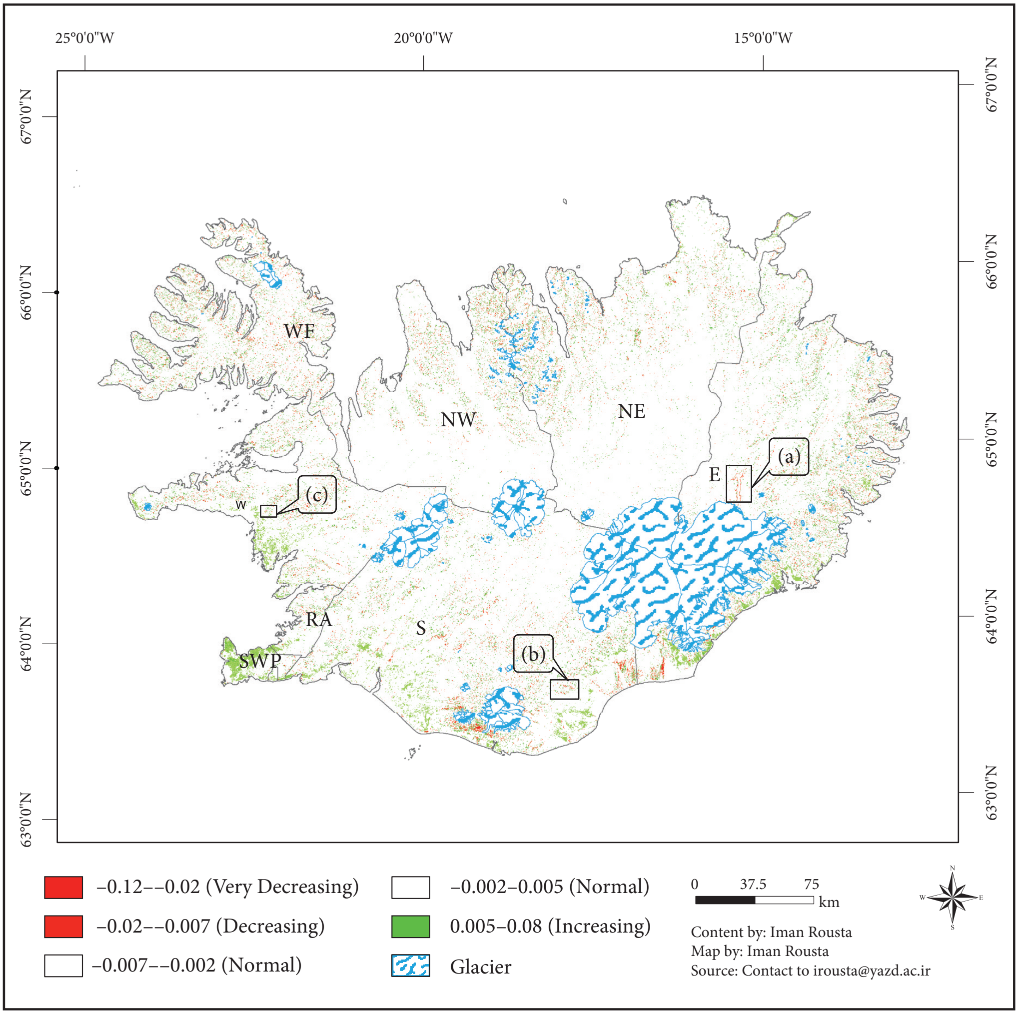

Figure 7: The map of the values of the NDVI index trends (NDVI/year) in Iceland during 2001–2018. (a) shorelines of artificial lake Hálslón, (b) Skaftá River, (c) landslide in Hítardalur.

4 Discussion

Not many studies on the regional, seasonal and annual spatial vegetation dynamics of Iceland were undertaken up to now. Our study is the first study that has assessed the vegetation variation in the whole of Iceland and its sub-regions using remote sensing. In the recent works dealing with the vegetation dynamics over the studied area, only a part of the country was analyzed (Lemenkova 2020b; Bates et al. 2021). In the case of study made for the whole country, vegetation variation and the inter-regional differences were not studied, and additionally, they employed satellite images having a lower spatial resolution, and analyzes were done for a shorter period (Raynolds et al. 2015). The satellite images used by Raynolds et al. (2015) were not trustable, and the next version (V006), which was unavailable at that time, could solve the uncertainties. Raynolds et al. (2015, 9495) said: »Version 6 of the MODIS Vegetation Indices products will correct this problem, but is not yet available«. It occurred that the MODIS NDVI images are useful for monitoring vegetation dynamics in Iceland and the method used in the study can be used for other regions and countries.

The results of this study indicated that the maximum vegetation coverage in Iceland occurs from the middle of July to late August, with an average area of 66,858 km^2 covered in vegetation (NDVI ≥ 0.2), which is about 65% of the country's territory. Also, the results showed that the growing season starts on average from late March and lasts up to the end of August.

Raynolds et al. (2015) in their study showed that a reduction in NDVI occurred in Iceland in the period from 2002 to 2013. The present study dealt with the period 2001–2018 and the results are in line with the results of the Raynold's team in the case of moderate decreasing trend and the high spatial variability of trends for the different regions of Iceland.

In the study, significant downtrends for the lower values of the NDVI were found, whereas, for higher values, positive uptrends were spotted. The reason for this effect is probably due to the growth of both planted, as well as natural forests, which again is in line with results presented in Raynolds et al. (2015). The total area of forests in Iceland has indeed increased from a total of 298 km^2 in the year 2000 to ~514 km^2 in 2020 (estimated value), whereas the area of other wooded lands increased from a total of 1344 km^2 in 2000 to ~1495 km^2 in 2020 (estimated value) (MacDicken 2015). A forest growing on grassland will most likely increase the NDVI for that area. As some of the new forests in Iceland do indeed grow on grasslands, they may simultaneously contribute to a reduction of the areas with a low value of the NDVI and an increase of the areas with higher NDVI value. The high positive trend in the maximum annual NDVI index value in the southern part of Iceland is in line with the widespread afforestation of that region (Fries 2017). The other studies about northern latitude's vegetation variations, indicate that there is a great increase in vegetation coverage between 45°N and 70°N (Myneni et al. 1997; Huang et al. 2017).

Substantial interannual variability in all of the analyzed classes of the NDVI values was found. This observation requires to be explored further in connection with the actual state of the atmosphere, especially with temperatures and precipitation.

The percentage of land covered by vegetation is by far the highest in the Southwest peninsula and the Reykjavik area (these are the smallest regions of the 8 main regions of Iceland). This is primarily due to the fact that both regions are located mostly at terrain having lower elevation. On the other hand, fieldwork showed that the high-density vegetation of that area is established after reclamation through the use of inorganic fertilizers and birch trees, which is consistent with the result of the Nyirenda (Nyirenda 2020) as well as the Reykjavik area has the most dense site of reforestation in the whole country (Fries 2017). In three regions, the West fjords, the Northeast, and the South, anomalously low vegetation coverage was spotted. The West fjords had much less vegetation coverage than the West even though their mean elevation is similar. Similarly, the Northeast had less vegetation coverage than the East, and the South had less vegetation than the Northwest, although their mean elevations are similar. The explanation for the West fjords having less vegetation than the West lies undoubtedly in a relatively cold climate in the West fjords (Einarsson 1984). As for the other regions with low-vegetation coverage, the explanation lies in the fact that the South and the Northeast are located in volcanically active zones, in which every few years eruptions occur, which in turn results in large areas with progressing erosion, even at relatively low altitudes (Arnalds, Ólafsson and Dagsson-Waldhauserova 2014; Lemenkova 2020b).

Only minor changes in the vegetation coverage in Iceland during the study period were observed, with the trend of changes significantly smaller than the inter-annual variability, which in turn must be considered as substantial. The total vegetation coverage was almost 67,000 km^2 (about 65% of the Iceland area), which is quite high for an island located in high latitudes, with a high elevation and a high share of land covered by glaciers and lakes.

5 Conclusion

Climate change and global warming can affect all areas around the world. It is predicted that the impact of climate change will be more severe for regions with higher latitudes (King et al. 2018; Anderson, Bayer and Edwards 2020), such as Iceland. Vegetation variations are surface phenomena, which could be a good indicator of climate change. The present study attempted to identify and analyze the spatio-temporal variations of the NDVI in both Iceland and its 8 sub-regions using remotely-sensed satellite images. It was found that MODIS NDVI images can be useful for monitoring the vegetation variations in the studied area.

The NDVI retrieved from remote sensing for the period 2001–2018 showed considerable inter-annual variability and a minor, statistically insignificant, decrease in the vegetation coverage in Iceland. In the late summer, 65% of Iceland is covered with vegetation (NDVI > 0.2). The areas with low NDVI (NDVI < 0.6) had a decreasing trend, whereas for the areas with high NDVI (NDVI > 0.6) an increase in the vegetation coverage was observed. In general, an increase in the NDVI was observed in the area of about 3260 km^2, whereas a decrease in the NDVI index was observed in the area of 1635 km^2, which is in line with an increase in forested areas in Iceland.

Vegetation coverage is influenced by such atmospheric parameters as temperature, precipitation, relative humidity, etc. On the other hand, all of these atmospheric parameters are influenced by atmospheric patterns and teleconnections. Therefore, to have a more accurate assessment of inter-seasonal, inter-annual, and inter-regional vegetation variations in the studied area, the atmosphere dynamics should be studied simultaneously with the vegetation variations. Up to now, one paper, in which the relationships between the atmospheric circulations and teleconnections with vegetation dynamics of Iceland (Olafsson and Rousta 2021) has already been published.

ACKNOWLEDGMENTS**:** Iman Rousta is deeply grateful to his supervisor (Haraldur Olafsson, Professor of Atmospheric Sciences, Institute for Atmospheric Sciences-Weather and Climate, and Department of Physics, University of Iceland, and Icelandic Meteorological Office (IMO)), for his great support, kind guidance, and encouragement. Author Contributions: H. O. and I. R. proposed the topic, commanded the data processing, analysis, and wrote the manuscript. Funding Statement: This work was supported by Vedurfelagid, Rannis and Rannsoknastofa i vedurfraedi. Conflicts of Interest: The authors declare no conflict of interest.

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Guidelines for contributing authors in Acta geographica Slovenica

EDITORIAL POLICIES

1 Focus and scope

The *Acta geographica Slovenica* journal is issued by the ZRC SAZU Anton Melik Geographical Institute, published by the ZRC SAZU Založba ZRC, and co-published by the Slovenian Academy of Sciences and Arts.

Acta geographica Slovenica publishes original research articles from all fields of geography and related disciplines, and provides a forum for discussing new aspects of theory, methods, issues, and research findings, especially in Central, Eastern and Southeastern Europe.

The journal accepts original research articles and review articles. Articles presenting new developments and innovative methods in geography are welcome. Submissions should address current research gaps and explore state-of-the-art issues. Research-based on case studies should have the added value of transnational comparison and should be integrated into established or new theoretical and conceptual frameworks.

The target readership is researchers, policymakers, students, and others who are studying or applying geography at various levels.

The journal is indexed in the following bibliographic databases: Clarivate Web of Science (SCIE – Science Citation Index Expanded; JCR – Journal Citation Report/Science Edition), Scopus, ERIH PLUS, GEOBASE Journals, Current Geographical Publications, EBSCOhost, Georef, FRANCIS, SJR (SCImago Journal & Country Rank), OCLC WorldCat, Google Scholar, and CrossRef.

2 Types of articles

Unsolicited or invited original research articles and review articles are accepted. Articles and materials or sections of them should not have been previously published or under consideration for publication elsewhere. The articles should cover subjects of current interest within the journal's scope.

3 Special issues

The journal also publishes special issues (thematic supplements). Special issues usually consist of invited articles and present a special topic, with an introduction by the (guest) editors. The introduction briefly presents the topic, summarizes the articles, and provides important implications.

4 Peer-review process

All articles are examined by the editor-in-chief. This includes fact-checking the content, spelling and grammar, writing style, and figures. Articles that appear to be plagiarized, are badly or ghost-written, have been published elsewhere, are outside the scope of the journal, or are of little interest to readers of *Acta geographica Slovenica* may be rejected. If the article exceeds the maximum length, the author(s) must shorten it before the article is reviewed. The article is then sent to responsible editors, who check the relevance, significance, originality, clarity, and quality of the article. If accepted for consideration, the articles are then sent to peer reviewer(s) for double-blind review. Articles are rejected or accepted based on the peer reviews and editorial board's decision.

5 Publication frequency

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AUTHOR GUIDELINES

Before submitting an article, please read the details on the journal's focus and scope, publication frequency, privacy statement, history, peer-review process, open-access policy, duties of participants, and publication ethics (all available at https://ags.zrc-sazu.si).

1 Types of articles

Unsolicited or invited original research articles and review articles are accepted. Articles and materials or sections of them should not have been previously published or under consideration for publication elsewhere. The articles should cover subjects of current interest within the journal's scope.

2 Special issues

The journal also publishes special issues (thematic supplements). Special issues usually consist of invited articles and present a special topic, with an introduction by the (guest) editors. The introduction briefly presents the topic, summarizes the articles, and provides important implications.

3 The articles

Research articles must be prepared using the journal's template (available at https://ags.zrc-sazu.si) and contain the following elements:

- **Title:** this should be clear, short, and simple.
- **Information about author(s):** submit names (without academic titles), affiliations, ORCiDs, and e-mail addresses through the online submission system (available at https://ags.zrc-sazu.si).
- **Highlights**: authors must provide 3–5 highlights. This section must not exceed 400 characters, including spaces.
- **Abstract:** introduce the topic clearly so that readers can relate it to other work by presenting the background, why the topic was selected, how it was studied, and what was discovered. It should contain one or two sentences about each section (introduction, methods, results, discussion, and conclusions). The maximum length is 800 characters including spaces.
- **Key words:** include up to seven informative key words. Start with the research field and end with the place and country.
- **Main text:** The main text must not exceed 30,000 characters, including spaces (without the title, affiliation, abstract, key words, highlights, reference list, and tables). Do not use footnotes or endnotes. Divide the article into sections with short, clear titles marked with numbers without final dots: **1 Section title**. Use only one level of subsections: **1.1 Subsection title**.

Research articles should have the following structure:

- **Introduction:** present the background of the research problem (trends and new perspectives), state of the art (current international discussion in the field), research gap, motivation, aim, and research questions.
- **Methods:** describe the study area, equipment, tools, models, programs, data collection, and analysis, define the variables, and justify the methods.
- **Results:** follow the research questions as presented in the introduction and briefly present the results.

- **Discussion:** interpret the results, generalize from them, and present related broader principles and relationships between the study and previous research. Critically assess the methods and their limitations, and discuss important implications of the results. Clarify unexpected results or lacking correlations.
- **Conclusion:** present the main implications of the findings, your interpretations, and unresolved questions, offering a short take-home message.

Review articles (narratives, best-practice examples, systematic approaches, etc.) should have the following structure:

- **Introduction:** include 1) the background; 2) the problem: trends, new perspectives, gaps, and conflicts; and 3) the motivation/justification.
- **Material and methods:** provide information such as data sources (e.g., bibliographic databases), search terms and search strategies, selection criteria (inclusion/exclusion of studies), the number of studies screened and included, and statistical methods of meta-analysis.
- **Literature review:** use subheadings to indicate the content of the various subsections. Possible structure: methodological approaches, models or theories, the extent of support for a given thesis, studies that agree with one another versus studies that disagree, chronological order, and geographical location.
- **Conclusions:** provide implications of the findings and your interpretations (separate from facts), identify unresolved questions, summarize, and draw conclusions.

– **Acknowledgments:** use when relevant. In this section, authors can specify the contribution of each author.
– **Reference list:** see the guidelines below.

4 Article submission

4.1 Open journal system

Author(s) must submit their contributions through the *Acta geographica Slovenica* Open Journal System (OJS; available at https://ags.zrc.sazu.si) using the Word document template (available at https://ags.zrc.sazu.si).

Enter all necessary information into the OJS. Any addition, deletion, or rearrangement of names of the author(s) in the authorship list should be made and confirmed by all coauthors before the manuscript has been accepted, and is only possible if approved by the journal editor.

To make anonymous peer review possible, the article text and figures should not include names of author(s).

Do not use contractions or excessive abbreviations. Use plain text, with sparing use of **bold** and *italics* (e.g. for non-English words). Do not use auto-formatting, such as section or list numbering and bullets.

If a text is unsatisfactory, the editorial board may return it to the author(s) for professional copyediting or reject the article. See the section on the peer-review process (available at https//ags.zrc-sazu.si) for details. Author(s) may suggest reviewers when submitting an article.

4.2 Language

Articles are published in English.

Articles can be submitted in English or Slovenian.

Authors must take care of high-quality English text. In the case of poor language, the article is copyedited/translated after acceptance by a professional chosen by the editorial board. In such a case, the translation or copyediting costs are borne by the author(s) and must be paid before layout editing.

All articles should have English and Slovenian abstracts.

4.3 Supplementary file submission

Supplementary files (figures) can be submitted to the OJS packed in one zip file not exceeding 50 MB.

4.4 Submission date

The journal publishes the submission date of articles. Please contact the editorial board (ags@zrc-sazu.si) with any questions.

5 Citations

Examples for citing publications are given below. **Citing »grey literature« is strongly discouraged**.

5.1 Citing articles

- Bole, D. 2004: Daily mobility of workers in Slovenia. Acta geographica Slovenica 44-1. DOI: https://doi.org/10.3986/AGS44102
- Fridl, J., Urbanc, M., Pipan, P. 2009: The importance of teachers' perception of space in education. Acta geographica Slovenica 49-2. DOI: https://doi.org/10.3986/AGS49205
- Gams, I. 1994a: Types of contact karst. Geografia Fisica e Dinamica Quaternaria 17.
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5.2 Citing books

- Cohen, J. 1988: Statistical power analysis for the behavioral sciences. New York.
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- Luc, M., Somorowska, U., Szmańda, J. B. (eds.) 2015: Landscape analysis and planning, Springer Geography. Heidelberg. DOI: https://doi.org/10.1007/978-3-319-13527-4
- Nared, J., Razpotnik Visković, N. (eds.) 2014: Managing cultural heritage sites in southeastern Europe. Ljubljana. DOI: https://doi.org/10.3986/9789610503675

5.3 Citing chapters of books or proceedings

- Gams, I. 1987: A contribution to the knowledge of the pattern of walls in the Mediterranean karst: A case study on the N. island Hvar, Yugoslavia. Karst and Man, Proceedings of the International Symposium on Human Influence in Karst. Ljubljana.
- Hrvatin, M., Perko, D., Komac, B., Zorn, M. 2006: Slovenia. Soil Erosion in Europe. Chichester. DOI: https://doi.org/10.1002/0470859202.ch25
- Komac, B., Zorn, M. 2010: Statistično modeliranje plazovitosti v državnem merilu. Od razumevanja do upravljanja. Naravne nesreče 1. Ljubljana.
- Zorn, M., Komac, B. 2013: Land degradation. Encyclopedia of Natural Hazards. Dordrecht. DOI: https://doi.org/10.1007/978-1-4020-4399-4_207

5.4 Citing expert reports, theses, dissertations and institutional reports

- Breg Valjavec, M. 2012: Geoinformatic methods for the detection of former waste disposal sites in karstic and nonkarstic regions (case study of dolines and gravel pits). Ph.D. thesis, University of Nova Gorica. Nova Gorica.

- Holmes, R. L., Adams, R. K., Fritts, H. C. 1986: Tree-ring chronologies of North America: California, Eastern Oregon and Northern Great Basin with procedures used in the chronology development work including user manual for computer program COFECHA and ARSTAN. Chronology Series 6. University of Arizona, Laboratory of tree-ring research. Tucson.
- Hrvatin, M. 2016: Morfometrične značilnosti površja na različnih kamninah v Sloveniji. Ph.D. thesis, Univerza na Primorskem. Koper.
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- World commission on environment and development 1987: Our common future: Brundtland report. Oxford.

5.5 Citing online materials with authors

- Tiran, J. 2021: Slovenija se je v celoti odela v modro. Metina lista. Internet: https://metinalista.si/slovenija-se-je-v-celoti-odela-v-modro/ (3. 11. 2021).
- Davies, G. 2017: The place of data papers: Producing data for geography and the geography of data production. Geo: Geography and Environment. Internet: https://blog.geographyandenvironment.com/2017/09/27/the-place-of-data-papers-producing-data-for-geography-and-the-geography-of-data-production/ (8. 11. 2021).

5.6 Citing websites without authors (e.g. websites of projects and institutions)

Use in-text citations only. It is not necessary to include a citation in the reference list. The in-text citation should include the URL.

5.7 Citing publicly archived data (e.g. statistical data)

Use in-text citations only. It is not necessary to include publicly archived datasets in the reference list. The in-text citation should include the name of the dataset, the institution providing the data and the time frame of the data used.

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- Popis prebivalstva, gospodinjstev, stanovanj in kmečkih gospodarstev v Republiki Sloveniji, 1991 – končni podatki. Zavod Republike Slovenije za statistiko. Ljubljana, 1993.
- Agriculture, forestry and fishery statistics. 2020 edition. Publications Office of the European Union. Luxembourg, 2020.

5.8 Citing geospatial data and cartographic materials

Geospatial data used in maps should be cited in the colophon on the map (see the Table and Figures section of the Authors' Guidelines). It is not necessary to include geospatial data in the reference list.

When cartographic materials are published as an independent monograph, add it to the reference list and use the following format:
- Buser, S. 1986: Osnovna geološka karta SFRJ 1 : 100.000, list Tolmin in Videm (Udine). Savezni geološki zavod. Beograd.
- Državna topografska karta Republike Slovenije 1 : 25.000, list Brežice. Geodetska uprava Republike Slovenije. Ljubljana, 1998.
- Franciscejski kataster za Kranjsko, k. o. Sv. Agata, list A02. Arhiv Republike Slovenije. Ljubljana, 1823–1869.
- The vegetation map of forest communities of Slovenia 1:400,000. Biološki inštitut Jovana Hadžija ZRC SAZU. Ljubljana, 2002.

5.9 Citing legal sources

Use in-text citation. It is not necessary to include a citation in the reference list. The in-text citation should include the title of legal document and the year.

5.10 In-text citation examples

All references in the reference list are cited in the text. In-text citations should include the last name of the author(s) or the name of the institution, and the year of publication. Separate individual citations by semicolons, arrange citations by year of publication, and separate the page information from author(s)' names and years by a comma; for example: (Melik 1955), (Melik, Ilešič and Vrišer 1963; Gams 1982a; Gams 1982b; World Commission on Environment and Development 1987). For references with more than three authors, cite only the first, followed by et al.: (Melik et al. 1956). Give page numbers only for direct quotations. Narrative citations: Perko (2016, 25) states: »Hotspots are …« or parenthetical citation (Kokole 1974, 7–8).

When citing online materials without authors, such as project or institutional websites, the URL should be included, for example: »The aim of the LABELSCAPE project is to develop mechanisms for integrating sustainability labels into tourism policy (https://labelscape.interreg-med.eu).«

When citing publicly archived data, such as statistical data, inform the reader in the text with the name of dataset, the time frame, and the institution that provides the data: »The 2000–2020 population data used in the analysis were provided by the Eurostat«. If the statistical data were published as a report, cite the document, e.g. (Popis prebivalstva … 1993).

When citing legal sources such as legislative acts, white papers, etc., you should provide (short formal) title and the year, for example: »… The European Commission's White paper on transport (2011) sets out ten strategic goals for a competitive and resource-efficient transport system: …«

5.11 Reference list

Arrange references alphabetically and then chronologically if necessary. Identify more than one reference by the same author(s) in the same year with the letters *a*, *b*, *c*, etc., after the year of publication: (1999a; 1999b). Use this format for indirect citations: (Gunn 2002, cited in Matei et al. 2014).

Include the Digital Object Identifier (DOI) in the reference if available. Format the DOI as follows: https://doi.org/… (for example: https://doi.org/10.3986/AGS.1812).

6 Tables and figures

Number all tables in the article uniformly with their own titles. The number and the text are separated by a colon, and the caption ends with a period. Example:

Table 1: Number of inhabitants of Ljubljana.

Table 2: Changes in average air temperature in Ljubljana (Velkavrh 2009).

Tables should contain no formatting and should not be too large; it is recommended that tables not exceed one page.

Upload figures to the OJS as separate supplementary files in digital form. If the graphic supplements prepared cannot be uploaded using these programs, consult the editorial board (ags@zrc-sazu.si) in advance.

Number all figures (maps, graphs, photographs) in the article uniformly with their own titles. Example:

Figure 1: Location of measurement points along the glacier.

All graphic materials must be adapted to the journal's format. Illustrations should be exactly 134 mm wide (one page) or 64 mm wide (half page, one column), and the height limit is 200 mm.

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Maps should be made in digital vector form with Corel Draw, Adobe Illustrator, or a similar program, especially if they contain text. They can exceptionally be produced in digital raster form with at least 300 dpi resolution, preferably in TIFF or JPG format. For maps made with *CorelDraw* or *Adobe Illustrator*, two separate files should be prepared; the original file (.cdr or .ai format) and an image file (.jpg format).

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Use Times New Roman for the legend (size 8) and colophon (size 6). List the author(s), scale, source, and copyright in the colophon. Write the colophon in English (and Slovenian, if applicable). Example:

Scale: 1:1,000,000
Content by: Drago Perko
Map by: Jerneja Fridl
Source: Statistical Office of the Republic of Slovenia 2002
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Graphs should be made in digital form using *Excel* on separate sheets and accompanied by data.
Photos must be in raster format with a resolution of 240 dots per cm or 600 dpi, preferably in .tif or .jpg formats; that is, about 3,200 dots per page width of the journal.

Figures containing a screenshot should be prepared at the highest possible screen resolution (Control Panel\All Control Panel Items\Display\Screen Resolution). The figure is made using Print Screen, and the captured screen is pasted to the selected graphic program (e.g., *Paint*) and saved as .tif. The size of the image or its resolution must not be changed.
Examples of appropriate graphic data formats: see the templates of maps in cdr and mxd files (available at https://ags.zrc.sazu.si) for a full-page map in landscape layout and an example of the correct file structure (available at https://ags.zrc.sazu.si) for submitting a map created with *ESRI ArcGIS*.

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As part of the submission process, authors are required to check off their submission's compliance with all of the following items, and submissions may be returned to authors that do not adhere to these guidelines.

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- The journal policies and guidelines have been reviewed and followed.

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- The list of authors is complete. Failure to do so may result in co-authors not being listed on the article at publication.
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- Tables are placed in the Word file with text at the appropriate place.
- The reference list was prepared following the guidelines.
- All references in the reference list are cited in the text.
- Where available, URLs and DOI numbers for references are provided.
- Supplementary files are in one .zip file.
- Authors agree that any costs of English proofreading are borne by the author(s). No additional costs are associated with the submission.
- The instructions for ensuring a double-blind review have been followed.

ACTA GEOGRAPHICA SLOVENICA EDITORIAL REVIEW FORM

This is a review form for editorial review (version 14) of an article submitted to the AGS journal.

This is an original scientific article.
(The article is original and the first presentation of research results with the focus on methods, theoretical aspects or a case study.)

- Yes
- No

The article follows the standard IMRAD/ILRAD scheme.

- Yes
- No

The article's content is suitable for reviewing in the AGS journal.
(The article is from the field of geography or related fields of interest, the presented topic is interesting for the readers of *Acta geographica Slovenica* and well presented. In case of negative answer add comments below.)

- Yes
- No

Editorial notes regarding the article's content.

The reference list is suitable (the author cites previously published articles with similar topics from other relevant geographic scientific journals).

- Yes, the author cited previously published articles on a similar topic.
- No, the author did not cite previously published articles on a similar topic.

Notes to editor-in-chief regarding previously published scientific work.

Is the language of the article appropriate and understandable?

RECOMMENDATION OF THE EDITOR

- The article is accepted and can be sent to the review process.
- Reconsider after a major revision (see notes).
- The article is rejected.

ACTA GEOGRAPHICA SLOVENICA REVIEW FORM

This is *Acta geographica Slovenica* review form (version 7).

1 RELEVANCE

Are the findings original and the article is therefore a significant one?

- yes
- no
- partly

Is the article suitable for the subject focus of the AGS journal?

- yes
- no

2 SIGNIFICANCE

Does the article discuss an important problem in geography or related fields?

- yes
- no
- partly

Does it bring relevant results for contemporary geography?

- yes
- no
- partly

What is the level of the novelty of research presented in the article?

- high
- middle
- low

3 ORIGINALITY

Has the article been already published or is too similar to work already published?

- yes
- no

Does the article discuss a new issue?

- yes
- no

Are the methods presented sound and adequate?

- yes
- no
- partly

Do the presented data support the conclusions?

- yes
- no
- partly

4 CLARITY

Is the article clear, logical and understandable?

- yes
- no

If necessary, add comments and recommendations to improve the clarity of the title, abstract, keywords, introduction, methods or conclusion:

5 QUALITY

Is the article technically sound? (If not, the author should discuss with the Editorial Board [ags@zrc-sazu.si] for assistance.)

- yes
- no

Does the article take into account relevant current and past research on the topic?

- yes
- no

Propose amendments, if no is selected:

Is the references list at the end of the article adequate?

- yes
- no

Propose amendments, if no is selected:

Is the quoting in the text appropriate?

- yes
- no
- partly

Propose amendments, if no is selected:
Which tables are not necessary?
Which figures are not necessary?

COMMENTS OF THE REVIEWER

Comments of the reviewer on the contents of the article:
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RECOMMENDATION OF THE REVIEWER TO THE EDITOR-IN-CHIEF

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PUBLISHER

Anton Melik Geographical Institute
Research Center of the Slovenian Academy of Sciences and Arts
PO Box 306
SI–1001 Ljubljana
Slovenia

SOURCES OF SUPPORT

The journal is subsidized by the Slovenian Research Agency and is issued in the framework of the Geography of Slovenia long-term core research programme (P6-0101). The journal is also supported by the Slovenian Academy of Sciences and Arts.

JOURNAL HISTORY

Acta geographica Slovenica (print version: ISSN: 1581-6613, digital version: ISSN: 1581-8314) was founded in 1952. It was originally named *Geografski zbornik / Acta geographica* (print ISSN 0373-4498, digital ISSN: 1408-8711). Altogether 42 volumes were published. In 2002 *Geographica Slovenica* (ISSN 0351-1731, founded in 1971, 35 volumes) was merged with the journal.

Since 2003 (from volume 43 onward) the name of the joint journal has been *Acta geographica Slovenica*. The journal continues the numbering system of the journal *Geografski zbornik / Acta geographica*.

Until 1976, the journal was published periodically, then once a year, from 2003 twice a year and from 2019 three times a year.

The online version of the journal has been available since 1995. In 2013, all volumes of the magazine were digitized from the beginning of its publication to 1994 inclusive.

All articles of the journal are available free of charge in digital form on the journal website http://ags.zrc-sazu.si.

Those interested in the history of the journal are invited to read the article »The History of *Acta geographica Slovenica*« in volume 50-1.

ISSN: 1581-6613
UDC – UDK: 91
ACTA GEOGRAPHICA SLOVENICA
GEOGRAFSKI ZBORNIK

62-1
2022

Print/tisk: Birografika Bori

Ljubljana 2022

ACTA GEOGRAPHICA SLOVENICA
GEOGRAFSKI ZBORNIK
62-1 • 2022

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ISSN 1581-6613
9 771581 661010