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Front cover photography: The Temple of Concordia (Agrigento, Italy) is one of the best preserved in the Valley of the Temples and resembles the logo of the international organization UNESCO. Cultural and natural heritage sites are often the focus of various research disciplines (photograph: Rok Ciglič).
Fotografija na naslovnici: Tempelj enotnosti (Agrigento, Italija) je eden izmed bolj ohranjenih v Dolini templjev in spominja na logotip mednarodne organizacije UNESCO. Kulturna in naravna dediščina sta pogosto v ospredju različnih raziskovalnih disciplin (fotografija: Rok Ciglič).

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SOCIO-DEMOGRAPHIC ANALYSIS OF BORDER REGIONS OF BOSNIA AND HERZEGOVINA

Aida Avdić, Boris Avdić, Ivan Zupanc

BORIS AVDIĆ

Border river Drina near Zvornik.

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Aida Avdić[1], Boris Avdić[1], Ivan Zupanc[2]

Socio-demographic analysis of border regions of Bosnia and Herzegovina

ABSTRACT: This paper analyses the statistical parameters that give a comprehensive overview of the socio-demographic state of the border areas of Bosnia and Herzegovina, and it represents a novel attempt to examine the disparity and relationships between central and peripheral parts of national territory. The methodology is based on examining the differences between border and non-border municipalities/cities according to four groups of indicators, to obtain four indices: depopulation, natural change, ageing and education. Statistically significant differences were found primarily in the context of population age structure, and it can be concluded that the ageing process has affected bordering regions more than the rest of the country.

KEY WORDS: border regions, Bosnia and Herzegovina, socio-demographic analysis, depopulation, natural change, ageing, education

Družbeno-demografska analiza obmejnih regij Bosne in Hercegovine

POVZETEK: Članek analizira statistične parametre, ki dajejo celovit pregled družbeno-demografskega stanja obmejnih območij Bosne in Hercegovine. Proučili smo neskladja in razmerja med osrednjimi in obmejnimi deli državnega ozemlja. Metodologija temelji na proučevanju razlik med obmejnimi in ostalimi občinami/mesti po štirih skupinah kazalnikov: depopulacija, naravni prirast, staranje prebivalstva in izobrazba. Statistično značilne razlike so bile ugotovljene predvsem v okviru starostne strukture prebivalstva, iz katerih lahko sklepamo, da je proces staranja bolj prizadel obmejne regije kot ostalo državo.

KLJUČNE BESEDE: mejne regije, Bosna in Hercegovina, družbeno-demografska analiza, depopulacija, naravne spremembe, staranje, izobrazba

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1 Introduction

Though geography as a science plays a pioneer role in the study of borders (Konrad 2015), modern borders are studied by a wide range of scientific disciplines, including anthropology, sociology, political science, psychology, law, ethnology and many others, all incorporated in new scientific discipline – border studies (Newman and Passi 1998; Amilhat Szary 2015). It is difficult to give a singular definition of a border, particularly since its function was equated exclusively with the geographical and sociological aspect for so long, with emphasis on the clear distinction between them (Newman 2003). Borders are a multi-significant institution that launches the process of transformation of space (Rumford 2006), not only in the administrative and political sense, but also in the economy, culture and society (Haselsberger 2014). In trying to seek out a single theoretical framework for border studies, many authors emphasize importance and significance of their spatial implications (Donnan and Wilson 1999; van Houtum 2000; Newman 2003; Paasi 2005). Amilhat Szary (2015) also points to the importance of placing emphasis on contemporary research on cross-border processes and socio-spatial issues in border regions. Klemenčić (2005) emphasizes the necessity of modernizing the geographical approach in border studies, which also implies the need for their analysis at the local level.

Perception of borders is critical in its spatial aspect. In listing four key approaches to the study of borders, Nail (2016) asserts that they cannot be isolated and considered separately from the bordering regions, particularly since they are usually drawn between different social and cultural groups. In light of the above, Axelsson (2013) states that the geographic interpretation of border function is mostly based on the spatial aspect, that is particularly pronounced in the border studies. According to Zorko and Šulc (2012), the term »borderland«, as a concept that pertains to the regions along state borders, appears as part of the globalization trends, as the evolution of the theory of state, territory and borders from the modern understanding to the post-modern, in the sense of an erosion of sovereignty, deterritorialization and globalization.

When examining national peripheries, as borderlands are often considered (not only in the geographic, but also in the developmental sense), a multidisciplinary approach is required. According to Anđelković-Stoilković, Devedžić and Vojković (2018), the initial approach is spatial, in which three aspects can be differentiated: causal, consequential and cause-and-effect. This concept is also applied in examining the periphery in the European Union (House 1980; Newman 2006).

Most studies examining the issue of border areas focus on the variety of development issues that these regions face, which justifies the premise that they (e.g., municipalities along the state border) are the periphery in the national context (van Houtum, 2000; van Geenhuizen and Rietveld 2002). Often, border areas are qualified as economically, socially and demographically lagging behind, particularly due to strong national centralism (House 1980; van Houtum 2000). The centre often resembles a concentration of economic activities, capital and decision-making power with great opportunities for development, while the periphery is considered a region of limited resources and small opportunities for innovation, resulting in socio-economic lagging or slower growth (Koči-Pavlaković 1996), although there are certain exceptional cases (Johnson 2009).

Borderlands research in Southeast Europe (e.g., in Serbia and Croatia) has applied a range of methodological approaches to confirm the hypothesis of border regions as economically, socially and demographically marginalized parts of the national territory (Popović and Radeljak 2011; Zorko 2012; Pejnović and Kordej-De Villa 2015; Vukmirović et al. 2016). In comparing the socio-economic indicators of border regions with the national average and examining the standard of living in these areas (Máliková et al. 2015; Đerčan et al. 2016), determining the incidence of demographic issues (Zupanc 2018; Anđelković-Stoilković 2019) and analyzing borderlands in the context of national security (Vukmirović et al. 2016), multiple authors have concluded that border regions are observed through the paradigm of spatial polarization due to the disparity in the levels of development between the center and periphery.

The study of borderlands and contextualization of social relations and processes within them are highly dependent on political circumstances (van Geenhuizen and Rietveld 2002), and that is the aspect where the case of Bosnia and Herzegovina is of special research interest. This is particularly reflected in the highly complex internal administrative division, regional disparities, weakened connections across internal territorial faults, as well as general political instability (Raos 2010; Reményi, Végh and Pap 2016; Avdić et al. 2022). Considering its overall socio-political situation through the prism of recent disintegration processes with emphasized internal specificities requires a different way of observing Bosnia and Herzegovina's

border regions, in relation to other borderlands. These processes influenced the character of Bosnia and Herzegovina border, which has a great political, historical and cultural relevance. On the other side, it is also worth of considering the impact of European Union borders, which can affect population stability in the adjacent regions, as indicated by Havlíček and Matušková (2002). An insight into their socio-demographic situation, which is the most susceptible to abovementioned influences, could indicate the existence of specificities, or even anomalies in already existing paradigms (Bryant 2004; Đerčan et. al. 2016; Anđelković-Stoilković 2019). Máliková et al. (2015) suggested that it would be interesting to follow the development of social indicators on the opposite side of external border of European Union, such as borderlands of Serbia and Bosnia and Herzegovina.

The border regions of Bosnia and Herzegovina have been relatively poorly studied, and have not frequently been the topic of scientific research, particularly in the context of demographic and socioeconomic development. Most papers on the topic examine the legal dimension, in terms of disputed segments and issues of verifying state borders with neighboring countries, and their historical and geographic development (Halilović and Suljić 2016; Spahić 2017). Osmanković (2008) examined the issue of cross-border cooperation in the context of economic development. Though borders were not the primary focus, they were mentioned in a paper on regional development and disparity, which emphasized the economic implications of the peripheral nature of certain border regions (Nurković 2006). However, to date, there have been no recent scientific or professional analysis of the borderlands in Bosnia and Herzegovina and their socio-demographic development. For that purpose, the task of this paper is to define the border areas of Bosnia and Herzegovina and to investigate the socio-demographic dimension of the level of its peripheral nature in order to add perspective of one highly complex and decentralized country to the theoretical framework of borderlands study.

2 Definition of borderlands of Bosnia and Herzegovina

Bosnia and Herzegovina is a nearly completely landlocked country, with only 24 kilometers of coastline in the sector of Neum and Klek, and a 13 kilometer long maritime border. The remainder of its state border (over 99%) is terrestrial, with 774 kilometers as land borders (primarily mountainous) and 751 kilometers as river borders (Lepirica 2009). Bosnia and Herzegovina borders Croatia to the north, west and south, while Serbia and Montenegro are located to the east. There are several standing border disputes with Croatia and Serbia (Halilović and Suljić 2016).

Delimitation methods for borderlands are often based on administrative criteria, encompassing the municipalities or regions along state borders. This principle is widely used, particularly in geographic research (Zupanc 2018; Anđelković-Stoilković 2019), because of the availability of statistical data, but there are also range of other criteria (Jeřábek et al. 2004; Bufon 2007; Nejašmić 2008; Máliková et al. 2015).

The border regions of Bosnia and Herzegovina are not uniformly defined spatially, neither in the formal nor in the scientific sense. The Act on Border Control uses the term »border zone« that encompasses the area from the state border to a depth of 10 kilometers, while the »Agreement between Bosnia and Herzegovina and the Republic of Croatia on border transport and cooperation« defined the border zone as an area to a depth of 5 kilometers from the shared border. A borderland buffer zone of a 10-kilometre width would partly encompass the territory of 59 municipalities or cities in Bosnia and Herzegovina. However, in many cases, this is only a small and virtually negligible part of the territory, which effectively does not give those local self-government units the true properties of a border area. For that reason, in this study, we have instead opted to apply an administrative criterion and to include in the border zone only those municipalities or cities that physically touch upon the state border (a total of 37). The majority of these local administrative units lies along border with Croatia (26 in total: Ravno, Neum, Čapljina, Ljubuški, Grude, Posušje, Tomislavgrad, Livno, Bosansko Grahovo, Bihać, Cazin, Velika Kladuša, Bužim, Bosanska Krupa, Novi Grad, Kostajnica, Kozarska Dubica, Gradiška, Srbac, Derventa, Brod, Odžak, Šamac, Domaljevac-Šamac, Orašje and Brčko). There are six border municipalities and cities bordering with Serbia (Bijeljina, Zvornik, Bratunac, Srebrenica, Višegrad and Rudo), and five with Montenegro (Čajniče, Foča, Gacko, Bileća and Trebinje). The remaining 105 local administrative units in Bosnia and Herzegovina are treated as the inland (non-border) zone, with the remark that one additional municipality (Stanari) was established since the last census. However, due to incomplete statistical data, that territory is here considered a part of the city of Doboj.

3 Methodology

Wide spectrum of demographic, economic and social criteria is used by various authors on the topic of borderlands development (Topaloglou et al. 2005; Máliková et al. 2015; Anđelković-Stoilković et al. 2018). This socio-demographic study is based on the official data from the 2013 census of Bosnia and Herzegovina, published by the Agency for Statistics of Bosnia and Herzegovina, and the vital statistics data for the five-year pre-pandemic period (2015–2019) released by both the national and entities statistics agencies. A total of 11 available numerical indicators were considered and classified into four groups: depopulation (population density and the population change index between the last two censuses in 1991 and 2013), natural change (birth and death rates, as well as calculated average of the vital index in the period 2015–2019), ageing (share of population under 15 years and over 65 years, as well as average age in 2013), and education (share of illiterate, computer literate and highly educated population in 2013). In order to obtain insight into whether there are evident differences between the Bosnia and Herzegovina bordering zones and interior of the country, all the above parameters were compared using descriptive statistics at the level of bordering vs non-bordering local administrative units (municipalities/cities), and the national average.

In the next phase of the methodological approach, the national average was calculated for each parameter and the values of all parameters placed on a scale where the national average has a value of 100. The following formula was used:

$$\text{SPI} = \frac{X_{m/c}}{X_{nat}} * 100;$$

where SPI is the simple parameter index of the municipality/city, is the value of the parameter for that municipality/city, and is the value of the parameter at the national level. For parameters where a higher numerical value indicates a poorer result (death rate, share of old population, average age and illiteracy rate), this formula was corrected using the inverse values of the parameters:

$$\text{SPI} = \frac{1/X_{m/c}}{1/X_{nat}} * 100.$$

Following this, a composite index was calculated for each group of parameters: depopulation index (DI), natural change index (NCI), ageing index (AI) and education index (EI), whose systematic numerical components give a uniform weighting. This in essence means that these composite indices are the arithmetic means of the included simple parameter indices.

To more precisely determine the statistical difference in these groups of parameters between border and non-border areas, inferential statistics methods were used; the t-test and chi-square test, with a standard level of significance of the p-value ($\alpha = 0.05$). These new values are used as variables in the t-test, in which states that there are no significant differences between the bordering and non-bordering municipalities/cities. For the purpose of chi-square test, municipalities with a composite index of less than 100 were categorized as less than national average, while those higher than 100 as above national average, and therefore these two categories served as the test variable. In this case, was the same as for the t-test. Considering that, unlike the t-test, non-parametric chi-square test eliminates the effect of standard deviation, which is very pronounced in some indicators, the parallel use of both of these methods has the function of drawing stronger conclusions about the (non)existence of statistically significant differences between bordering and non-bordering municipalities/cities, as well as easier detection of eventual anomalies and data distortion outliers.

In order to get a more comprehensive picture of socio-demographic development of Bosnia and Herzegovina's borderlands, in the final methodological phase a simple method of municipalities/cities classification is designed. By combining the four composite indices, all the local administrative units in Bosnia and Herzegovina were classified into five categories, with the focus on the bordering municipalities/cities. The first category contains the municipalities and cities with the most favorable socio-demographic characteristics, i.e., those in which all four composite indices had above average values in relation to the national level. The second category includes municipalities/cities with three out of four above-average indices; the municipalities/cities in the third category has two out of four above average indices, while the fourth one is characterized by only one above average composite index. The fifth category contains those municipalities/cities where all the composite indices were below the national average. Although these categories do not

represent statistically or spatially profound clusters, this kind of classification can be considered useful in order to address basic level of socio-demographic disparities in the studied regions in combination with cartographic choropleth method.

4 Results

In examining the average values of the selected socio-demographic indicators (Table 1), it can be concluded that the borderlands of Bosnia and Herzegovina have less favorable parameters in relation to the non-border areas in 9 out of 11 cases – the exemptions are population change index and percentage of young population. However, in order to obtain clearer conclusions on the significance of differences between border and non-border regions, below we present the results of the inferential analysis (Table 2 for t-test; Table 3 for chi-square test) that is based on the values of the selected parameters for each individual municipality or city.

The lack of significant differences in the population change index for the period 1991–2013 between the border and non-border areas in Bosnia and Herzegovina was confirmed through both inferential methods. This in particular refers to the parametric t-test method, which is based on a comparison of mean SPI for two categories municipality/city, t ametric chi-square test, χ^2 (1, N = 142) = 1.7, p = 0.193, since it

Table 1: Average values of selected socio-demographic indicators for border and non-border regions of Bosnia and Herzegovina.

Selected variables	Bordering municipalities	Non-bordering municipalities	National average	Standard deviation (national level)
Population change index	81	80	81	29
Population density (people per km^2)	57	75	69	594
Birth rate 2015-19 (‰)	7.3	8.6	8.2	2.9
Death rate 2015-19 (‰)	11.3	11.1	11.1	4.5
Vital index 2015-19	0.64	0.78	0.74	0.32
Young population (%)	15.5	15.4	15.4	2.6
Old population (%)	14.9	14.0	14.2	5.5
Average age	39.8	39.4	39.5	3.5
Highly-educated population (%)	8.0	10.1	9.6	4.4
Computer literacy (%)	29.1	34.,0	32.6	7.4
Illiteracy rate (%)	2.84	2.81	2.81	2.8

Table 2: Mean simple parameter indices of socio-demographic indicators for bordering and non-bordering municipalities/cities with t-test results.

Selected variables	Bordering municipalities	Non-bordering municipalities	t	p
Population change index (mean SPI)	102	97	0.7	0.517
Population density (mean SPI)	101	282	–1.8	0.068
DEPOPULATION INDEKS	102	190	–1.8	0.077
Birth rate 2015-19 (mean SPI)	73	90	–2.2	0.005
Death rate 2015-19 (mean SPI)	199	98	1.5	0.221
Vital index 2015-19 (mean SPI)	76	87	–1.7	0.098
NATURAL CHANGE INDEKS	116	92	0.0	0.973
Young population (mean SPI)	96	96	0.2	0.853
Old population (mean SPI)	84	84	–4.0	0.000
Average age (mean SPI)	95	95	–3.4	0.001
AGEING INDEX	91	91	–3.1	0.002
Highly-educated population (mean SPI)	85	78	0.9	0.377
Computer literacy (mean SPI)	80	79	0.3	0.790
Illiteracy rate (mean SPI)	121	100	2.0	0.050
EDUCATION INDEX	95	86	1.5	0.131

shows that a larger number of municipalities/cities higher than the national average than expected were located in the border zone in comparison to inland regions, which is contrary to the assumption that the border zones are exposed to greater depopulation. On the other hand, the high standard deviation affected the higher SPI for population density. However, for this parameter the t-test again did not reveal a statistically significant difference, even though the value came close to significant level, tvery low level of significance, χ^2 (1, N = 142) = 0.1, p = 0.719. Very similar inferential indices were also obtained for the depopulation index (DI), as a composite parameter, tlculations, the general conclusion is that no significant differences were found between the border and non-border zones in Bosnia and Herzegovina in the context of depopulation.

The absence of a significant difference in this context indicates that 46% of the border municipalities/cities have above average value of the depopulation index, which is nearly identical to the ratio for the total number of local administrative units in Bosnia and Herzegovina. The abovementioned municipalities/cities in the border region mostly clustered into three regions: Herzegovina, Bosanska Krajina and Northeast Bosnia. In judging by the values of the depopulation index (DI), a particularly favorable situation was seen in four local administrative units: Cazin (DI = 199), Bužim (DI = 179), Brčko (DI = 181) and Bijeljina (DI = 175). On the other hand, the highest level of depopulation was seen in Bosansko Grahovo in the west and Srebrenica in the east, which have lost more than half of their pre-war population, mostly as war fatalities (or genocide in the case of Srebrenica) and migration. The population of Eastern Bosnia is generally characterized by very unfavorable depopulation parameters.

Concerning the natural change index (NCI) for the period 2015–2019, the component parameters considered were birth rate, death rate and vital index. Since the first two parameters are calculated as the value per 1000 inhabitants on the basis of the number of those born and died, and the assessment of the population in the given years, the vital index is used as a means to control any estimating errors. While the birth rate was found to differ with strong statistical significance between the border and non-border municipalities/cities in favor of the latter, both in parametric, t(71) = –2.2, p = 0.005, and non-parametric tests, χ^2 (1, N = 142) = 9.0, p = 0.003, no significant differences were found for the death rate, t(42) = 1.5, p = 0.221; χ^2 (1, N = 142) = 0.1, p = 0.783. To better illustrate this contrast, those municipalities/cities that were above the national average for natality comprise just 16% of the bordering local administrative units, while above average mortality was seen in 46% of them. The obtained inferential values for the vital index gave mixed results. The non-parametric chi-square method showed that there is a statistically significant difference in favor of non-border areas, χ^2 (1, N = 142) = 6.0, p = 0.015, while the t-test did not give a significant result. These results indicate the evident distortion of data in just a few specific municipalities.

Table 3: Chi-square test results for above and below average socio-demographic indicators values in bordering and non-bordering municipalities/cities of Bosnia and Herzegovina.

Selected variables	Bordering municipalities		Non-bordering municipalities		χ^2	p
	Above average	Below average	Above average	Below average		
Population change index (mean SPI)	19	18	41	64	1.7	0.193
Population density (mean SPI)	16	21	49	56	0.1	0.719
DEPOPULATION INDEX	17	20	50	55	0.0	0.861
Birth rate 2015-19 (mean SPI)	6	31	45	60	9.0	0.003
Death rate 2015-19 (mean SPI)	17	20	51	54	0.1	0.783
Vital index 2015-19 (mean SPI)	6	31	39	66	6.0	0.014
NATURAL CHANGE INDEX	9	28	42	63	8.9	0.003
Young population (mean SPI)	14	23	42	63	0.1	0.817
Old population (mean SPI)	8	29	56	49	11.1	0.001
Average age (mean SPI)	9	28	57	48	9.9	0.002
AGEING INDEX	8	31	54	51	9.9	0.002
Highly-educated population (mean SPI)	11	26	20	85	1.8	0.176
Computer literacy (mean SPI)	2	35	14	91	1.7	0.190
Illiteracy rate (mean SPI)	22	15	38	67	6.1	0.014
EDUCATION INDEX	13	24	22	83	3.0	0.085

The same factor also explains the highly unusual values of the natural change index and the very discrepant significance levels obtained by both tests, $t(42) = 0.0$, $p = 0.973$; χ^2 $(1, N = 142) = 8.9$, $p = 0.003$.

The above average values of the natural change index (NCI) were confirmed in 27% of bordering local administrative units. Among them, no significant evidence of clustering was detected, with the exception of Bužim (NCI = 159), Velika Kladuša (NCI = 134) and Cazin (NCI = 110) in the Krajina region, where these parameters again have a visible higher value than the national average. Due to the seemingly low death rate, the sparsely populated municipality of Ravno in the Herzegovina region has unreasonably high natural change index (NCI = 563). In the negative context, Bosansko Grahovo was again in first place (NCI = 40), and it should be stated that virtually the entire northern border region showed below average values of this parameter, even though it is not a sparsely populated area. The eastern borderlands were found to be relatively heterogeneous for this index.

The overall ageing index (AI) showed a statistically significant difference between border and non-border municipalities/cities, $t(72) = -3.1$, $p = 0.002$; χ^2 $(1, N = 142) = 9.9$, $p = 0.002$. This primarily pertains to the ratio of the elderly population (above 65 years) and average age. Though at first glance these indicators do not appear to be so different between the border and non-border areas as a whole (Table 1), when viewed in relation to the local administrative units, these differences achieve a very high level of significance, both in the parametric, $t(82) = -4.0$, $p = 0.000$; $t(69) = -3{,}4$, $p = 0.001$, and non-parametric tests, χ^2 $(1, N = 142) = 11.1$, $p = 0.001$; χ^2 $(1, N = 142) = 9.9$, $p = 0.002$. This leads to the clear conclusion that bordering municipalities/cities have a significantly higher share of the older population and a significantly higher average age of the overall population in comparison to non-border areas. However, there is a high similarity between regions in the share of the young population (under 15 years), which was nearly the same in both groups of municipalities/cities, $t(60) = 0.2$, $p = 0.853$; χ^2 $(1, N = 142) = 0.1$, $p = 0.817$.

Only eight bordering municipalities (22%) had an above average value of the ageing index (AI), while all others showed an unfavorable age structure of the population (higher degree of general ageing) in relation to the national average. The most favorable findings (generally the youngest populations) were as expected in four local administrative units in the Krajina region: Bužim (AI = 174), Cazin (AI = 128), Velika Kladuša (AI = 123) and Bosanska Krupa (AI = 118). A relative surprise in this category were four municipalities/cities in Republika Srpska (Gradiška, Srebrenica, Gacko and Bileća) since all but the first are situated in the depopulation hit eastern part of the country. Bosansko Grahovo is the western municipality with the least favorable population age structure (AI = 50), followed by Ravno in the south, Kozarska Dubica in the north, as well as Rudo and Čajniče in the east.

The results regarding education index (EI) revealed some surprising and contradictory trends. No statistically significant differences were found between border and non-border municipalities/cities for the share of highly educated population. However, it was surprising to see that the mean SPI was higher in the border than the non-border zone, despite the location of the most important university centers inland, and that nearly one-third (31%) of border municipalities/cities were above the national average for this indicator, as opposed to less than one-fifth (19%) of non-border local administrative units. For computer literacy, a massive difference was detected between the large urban centers and small rural areas, and only two border cities (6%) had an above average number of computer literate people. However, these differences were not found to be statistically significant, particularly with the t-test, $t(116) = 0.3$, $p = 0.790$. Statistical significance was only found in the difference of general illiteracy rates, in favor of the border areas. An above average SPI for literacy was found in 59% of border and only 36% of non-border municipalities/cities. Both parametric, $t(69) = 2.0$, $p = 0.050$, and non-parametric tests, χ^2 $(1, N = 142) = 6.1$, $p = 0.014$, showed that the differences between these two groups of local administrative units were statistically significant.

In terms of the regional differences in the education structure of the borderland population of Bosnia and Herzegovina, there is a prominent disparity between north and south. Namely, all the municipalities and cities of the borderlands in the Herzegovina region had an above average education index, while nearly the entire Podrinje region (with the exception of Foča) in the east, Posavina region (with the exception of Orašje) in the north, and Krajina region (with the exception of Bihać) showed a below average value of this parameter. Trebinje, as the main urban centre of the Eastern Herzegovina region stood out the most for this index (EI = 186). It is interesting that the spatial pattern in this case is completely opposite to the parameters describing depopulation. An explanation of this phenomenon can be sought in the negative correlation with the share of the agricultural population.

By combining the four composite indices, all the local administrative units in Bosnia and Herzegovina were classified into five categories, with the focus on the bordering municipalities/cities (Figure 1). The first category contains the municipalities and cities with the most favorable socio-demographic characteristics, i.e., those in which all four composite indices had above average values in relation to the national level. The fifth category contains all those municipalities/cities where all the composite indices were below the national average. At the national level, only eight municipalities/cities could be categorized in the first group, and out of these, four are found in the Sarajevo Canton and none lie within the border area. The second category contains five bordering municipalities/cities, with three in the Krajina region (Cazin, Velika Kladuša and Bužim) and two in the Hercegovina region (Posušje and Ravno). The third category contains eight municipalities/cities, with five in the Herzegovina region (Čapljina, Ljubuški, Grude, Trebinje and Gacko), and three in the Northeast Bosnia region (Brčko, Orašje and Zvornik). The fourth category included the largest number of border municipalities/cities, with a total of 17: Bihać, Bosanska Krupa, Kostajnica, Gradiška, Srbac, Odžak, Šamac, Domaljevac-Šamac, Bijeljina, Bratunac, Srebrenica, Višegrad, Foča, Bileća,

Figure 1: Socio-demographic categories of the municipalities/cities in borderland of Bosnia and Herzegovina.

Neum, Tomislavgrad and Livno. In all these cases, only one composite index showed an above average value, which is particularly surprising for Bihać and Bijeljina, as important regional centres. Finally, the fifth category contains seven municipalities: Novi Grad, Kozarska Dubica, Derventa, Brod, Rudo, Čajniče and Bosansko Grahovo. All these municipalities have a predominantly ethnic Serb population, and with the exception of the latter, all of them are located in the entity of Republika Srpska.

5 Discussion and conclusions

Here is presented a novel approach to examination of geographic and socio-demographic characteristics of the specific borderlands, that have not been a commonly studied topic to date in any scientific discipline that deals with similar issues, and therefore the approach and methodology applied here could be of multiple benefit in a range of contexts. Research methodology is adjusted to the circumstances of demographic underdevelopment and multiple statistical basis deficiencies, as well as to the context of recently disintegrated political territories (following the breakup of SFR Yugoslavia – Akrap 2008; Gosar 2012), where internal divisions and disparities often exceed those in bordering zones. Somewhat surprising results of this research partially changed the paradigm of bordering regions as national and functional periphery (House 1980), and pointed to the obvious need for comprehensive approach to the study of social phenomena of borderlands (Lorentzen 2012; Haselsberger 2014), by taking into consideration their demographic, economic, historical, cultural, environmental and other specificities. Geographical aspect of border studies is substantial to revelation of complex relations in regions adjacent to international borders, and this study is just an example of putting socio-demographic features into proper spatial context.

The results obtained in this research indicate that there are significant differences in the ageing index of the border municipalities/cities of Bosnia and Herzegovina in relation to non-border areas. This primarily pertains to the share of the older population, which is higher than the national average in nearly 80% of border municipalities, and of average population age. These findings point out to advanced stages of the demographic ageing process, which is characteristic of the borderlands of this country. Age structure of borderlands population can be explained by the action of multiple factors, such as migration (with a pronounced emigration component that is further intensified by its border status, due to faster crossing of the border, proximity to developed cities in neighboring countries, etc.). The increasing share of the older population can also be associated with the reduced birth rates, and a reduction or stabilization of the death rate (Nejašmić and Toskić 2016). Examining the broader region, a similar situation can be observed in the Serbian borderlands, in which demographic ageing is also more prominent in relation to other, non-border areas (Anđelković-Stoilković 2019). On the other hand, in Croatia there are no significant differences in the level of population ageing between the border and non-border municipalities, indicating a pronounced homogenization of the ageing process at the national level (Nejašmić and Toskić 2013).

It was surprising that no significant level was detected in the general differences concerning depopulation, vital statistics (for parametric test) and education between border and non-border municipalities or cities, since somewhat more pronounced deprivation parameters were expected in the border areas, as a generally accepted demographic pattern of the peripheral areas of neighboring Croatia (Pokos and Mišetić 2009) and Serbia (Vukmirović et al. 2016). The values of the death rate in border areas did not differ from those recorded inland, which is an anomaly, taking into account the unfavorable age structure. However, the peripheral position in the national context does not always necessarily mean marginalization in the sense of availability of certain services, such as health care and education. This is supported by the results of the analysis of the education index, where a lack of significant differences is attributed to the proximity of university centers in the neighboring countries and the positive cross-border influences. The largest differences within this composite index were seen in illiteracy rates, which were unexpectedly lower in the border areas, primarily due to the municipalities/cities in the Herzegovina region. A higher illiteracy rate in the inland areas can be attributed to various factors, including the dominance of mountainous terrain, where access to education was limited in the past (Emirhafizović and Zolić 2017; Pašalić Kreso 2017).

This research however did not provide a clear and uniform conclusion on the differentiation of border and non-border municipalities/cities in the context of the socio-demographic indicators, which could be ascribed to the high diversification of the border regions. This is best seen in the example of Cazinska Krajina and Herzegovina regions, whose demographic indicators are more favorable in relation to the

national average, as opposed to Posavina and Podrinje regions on the other hand, which showed pronounced unfavorable socio-demographic characteristics. Cazinska Krajina (Cazin, Velika Kladuša and Bužim) is a historical region that traditionally represents one of the most vital regions in Bosnia and Herzegovina in demographic sense. This can be explained by the ethno-cultural factors (the area is homogenously inhabited by the Bosniak or Muslim population) and the strongly pronounced traditionalist identity (Lojić-Duraković 2019), that is reflected in the relatively high birth rate. For these reasons, Cazinska Krajina does not fall within the typical peripheral areas, at least not in the context of demographic indicators. The same is true for Herzegovina, which shows somewhat reduced population density due to the natural predisposition of the region, but the traditional elements and pronounced ethno-religious homogeneity (Croatian/Catholic in Western Herzegovina, and Serbian/Orthodox in Eastern Herzegovina) contribute to a more stable population dynamic. Herzegovina also borders with one of Croatia's most developed tourism regions – Dalmatia, and the border between these areas in the cultural sense is highly permeable, which is also reflected in the higher degree of cross-border cooperation (Jurilj 2020). On the other hand, the Posavina and Podrinje regions are heavily war-affected areas, and the direct demographic losses continue to be a very present factor even today. It is important to emphasize that cluster analysis with inclusion of other available socio-economic indicators would provide statistically more substantiated model regarding explanation of borderland heterogeneity and connections within it, so we think that this suggestion should be taken into consideration regarding future research on this topic.

Limitations in the research process primarily concern the issue of fictitious statistics and the lack of relevant socio-economic indicators. The available data are quite scarce and limit the opportunities for creating standard or widely accepted composite indicators, such as the human development index, human poverty index or multiple deprivation index. This disables any testing of correlations between demographic with economic indicators, which would give clearer and more specific insight into the social processes ongoing in border regions, and would also open the path for a clearer clustering of municipalities and cities. It is also necessary to keep in mind that the ethnic structure of the population in the study area largely influenced the results obtained, even though this factor was not treated as a variable in the research. However, the indicators considered during this study provide a sufficient basis to assess the demographic potential and resources within a given local area. The obtained results indicate a need to consider the heterogeneity of the borderlands of Bosnia and Herzegovina in future studies. This suggests the need to more clearly identify the factors causing the heterogeneity of processes in the different border regions of Bosnia and Herzegovina. Meanwhile, in order to obtain deeper insight into the socio-cultural processes in this space, it would be desirable to include a survey of the local population in future research.

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FROM INDUSTRIAL DISTRICTS TO INDUSTRIAL SYMBIOSIS: AN OPPORTUNITY. THE CASE OF THE PONTE ROSSO INDUSTRIAL AREA, ITALY

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The industrial zone north of Spilimbergo – the fusion between the Consortium of Ponte Rosso and the Consortium of Spilimbergo.

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From industrial district to industrial symbiosis: An opportunity. The case of the Ponte Rosso industrial area, Italy

ABSTRACT: The article highlights the importance of industrial symbiosis in the industrial ecology literature, which refers to geographically close relationships between companies in which networks and geographic proximity play a vital role. Industrial symbiosis traditionally deals with different industries in a collective approach to economic and environmental management. The research was carried out in the northeast of Italy in the autonomous region of Friuli Venezia Giulia, close to the Slovenian border. The Ponte Rosso was used as a case study. The empirical analysis served to highlight some critical aspects of the environmental, geographic-economic, and social factors that could hinder the development of industrial symbiosis in this region.

KEY WORDS: industrial districts, industrial symbiosis, industrial symbiotic networks, economic geography, Friuli Venezia Giulia

Od industrijskega distrikta do industrijske simbioze: Priložnost. Primer industrijskega območja Ponte Rosso, Italija

POVZETEK: Članek prikazuje pomen bistvenega pojava v literaturi o industrijski ekologiji, ki označuje geografsko tesne odnose med podjetji, v katerih igrajo omrežja in geografska bližina ključno vlogo – industrijske simbioze. Ta se tradicionalno ukvarja z ločenimi panogami v skupnem pristopu poslovanja in ravnanja z okoljem. Raziskava je bila izvedena na severovzhodu Italije v Avtonomni deželi Furlaniji Julijski krajini, v neposredni bližini slovenske meje. Ponte Rosso je bil vzet kot primer, za katerega so značilne priznane okoljske, geografske, gospodarske in družbene koristi. Z empirično analizo izpostavljamo nekatere ključne vidike okoljskih, geografsko-ekonomskih in družbenih dejavnikov, ki so ovira razvoja industrijske simbioze v tej regiji.

KLJUČNE BESEDE: industrijski distrikti, industrijska simbioza, industrijska simbiotska omrežja, ekonomska geografija, Furlanija – Julijska krajina

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1 Introduction

The term industrial symbiosis was first used by Renner (1947) to describe the »organic relationship« between different industries, including the use of the waste products of one input for another, and later defined by Christensen (1992, cited in Chertow 2000) with the famous industrial symbiosis case Kalundborg, an eco-industrial park in Denmark. Later, Chertow (2000), Chertow and Lombardi (2005), and Mirata and Pearce (2006) provided definitions of industrial ecology and circular economy. Industrial symbiosis, a sub-field of industrial ecology, is concerned with the cyclical flow of resources through business networks. The main goal of industrial symbiosis is to support the industrial organisation by getting companies to think beyond the boundaries of the individual company at a broader systems level (Chertow 2000).

The first approach to this concept was eco-industrial parks and islands of sustainability. They grew out of the idea of creating »industrial biocenoses« around certain industries. So-called clusters would produce minimal emissions due to the exchange of materials between the sectors involved (Erkman 2002).

In 1989, a cluster of companies from different industries was established in Denmark that intensively distributed resources (Knight 1990, cited in Chertow 2007). As noted by Taddeo et al. (2017), clusters are one of the most effective models for local industrial growth and are considered a good starting point for industrial symbiosis projects.

At this point, we refer to the concept of circular economy, which aims to bring industrial systems closer to environmental and social protection. In the circular economy, waste from production and consumption circulates as a new input in the same or a different process (Ellen … 2013).

The circular economy approach is one of the fundamental concepts within industrial symbiosis. It envisions a recuperative system in which materials flow in a stable system that provides a balance between economic and industrial development and geographic and environmental resource protection (Džajić Uršič 2020). In the context of the circular economy, industrial symbiosis can be considered a strong archetype of a business model based on shared infrastructure and by-products to improve resource efficiency and create value from waste. Minor or broader collaborations within the industrial symbiosis reduce the need for raw materials and waste disposal, thus closing the material loop (González-Val and Pueyo 2019; Papetti et al. 2019).

Gibbs and Deutz (2005) note that it is unclear whether the exchange of by-products should be considered as a defining feature of an eco-industrial park or/and industrial symbiosis, leading to an ambiguous and inconsistent use of the terms, which is still controversial. Some authors consider eco-industrial parks as one of the ways to create industrial symbiosis, as Chertow (2007) states.

The literature on economic and industrial geography has significantly influenced industrial geographic analysis. For instance, geographic proximity has become a major factor in managing social synergies in industries in industrial symbiosis. It reduces transportation costs and energy depletion and indicates sufficient material supply from the surrounding companies to make industrial symbiosis more sustainable (Ehrenfeld and Gertler 1997). For an efficient industrial symbiosis structure, geographic proximity should be considered as a relevant variable for navigating through social ecosystems such as industrial districts (Howard-Grenville and Paquin 2008; Jensen et al. 2011). On the other hand, the dynamic evolution of industrial networks that develop in complex environments does not allow companies involved in the exchange of by-products to calculate their optimal geographic location for suppliers and consumers using traditional linear methods (Staber 2001; Morales and Diemer 2019).

The literature on geographic economics now offers opportunities to think about some critical factors from a geographic point of view: industrial location, land, spatiality, spatial diversity, undefined development, spatial embeddedness, path dependence, and scaling (Beaurain and Varlet 2015; Boutillier et al. 2015).

Let us start with the concept of clustering, proposed by an economist Alfred Marshall (2013). He tried to identify the reasons that make the agglomeration of specialised industries a territorial phenomenon worth studying (Jelen 1993; Storper 1997; Porter 1998; Becattini et al. 2003). Since 1990, the concepts of industrial district and cluster have been widely used, and the term industrial district is commonly used in the economic literature (Markusen 2003; Lazzeretti 2006; Ortega-Colomer, Molina-Morales and Fernández de Lucio 2016). In the 1980s, Marshall's concept of the industrial district was used as a new unit for analysis of industry-specific enterprises clustering based on a socio-economic approach to industrial organisation (Becattini 1987). Later, Porter (1989), starting from his interest in the combination of competitive forces which give impetus within the economic system to specific specialised clusters formed through inter-organisational

networks, proposed the territorial cluster. Becattini (1987) often cited territorial clusters as a typical example of industrial districts (Becattini et al. 2003). A cluster approach can be limiting if the geography is defined by a rigid boundary (Henriques et al. 2022). Often, the industrial area is interpreted as a cognitive system or »cognitive laboratory« where knowledge and information are elaborated in a complex way. Culture and social values are created, and the companies' effectiveness drives unspoken understanding, a social-productive system in which knowledge, social experiences, mental models and collective beliefs are accumulated over time in a given space. Geographic proximity favours the exchange of information and knowledge among co-located stakeholders (Neves et al. 2020). In this approach, the industrial area must be understood as a complex system of knowledge generation, absorption, and sharing, as well as a network of social interactions« (Becattini et al. 2003). From the above, the crucial role of trust emerges. The importance of this social dimension in industrial areas is often recognized in the literature (Ehrenfeld and Gertler 1997; Gibbs and Deutz 2005; Gibbs and Deutz 2007; Tudor et al. 2007).

In the Autonomous Region of Friuli Venezia Giulia, there are seven industrial districts that, despite their geographical location, use the concept of industrial symbiosis as a collective approach to competitive advantage. They achieve economic and environmental benefits while taking social aspects into account (Chertow 2007).

The article aims to present the crucial positive and negative highlights in the current geographical, organisational and economic areas. They show the importance of companies belonging to foreign multinationals present in industrial districts; the awareness of smaller, younger and expert companies for the sustainable development of the area; the relationships between different types of companies within production systems; social aspects of synergies and mechanisms between companies and their formation; strong and mutual dependencies between industrial districts, disregarding some characteristics, such as size, organisational structure, economic income and age.

To achieve this goal, a comprehensive assessment methodology was developed and carried out. This study is divided into two sequential phases: first, the industrial districts in the Autonomous Region of Friuli Venezia Giulia were analysed, and in the second phase, primary data were collected in the field. A comprehensive analysis is proposed to interpret the role of factors influencing the development of industrial symbiosis. As driving forces, networks were considered as 'institutions' (laws, central concerns for direction, the formal mechanism for policy rule-making and enforcement), 'social networks' (social structure consisting of a set of social actors such as individuals), and 'cognitive frames' (norms, values) (Beckert 2010; Džajić Uršič 2020; Jelen et al. 2020).

2 Friuli Venezia Giulia and the case of Ponte Rosso

It is undeniable the Italian regional governments are actively incorporating concepts such as the eco-industrial park into their local policies, beginning with a 1998 national law (Italian Legislative Decree 112/98) designed to promote industrial development. This proposed a model for environmentally sustainable local industrial development or a system based on shared utilities, infrastructure, and services called »ecologically equipped industrial areas« (Daddi et al. 2016; Taddeo 2016; Taddeo et al. 2017). As Daddi et al. (2016) noted, this model has been a national challenge to outline a new organisational standard of production activity inspired by the principles of industrial ecology.

Few studies describe industrial symbiosis cases in the Autonomous Region Friuli Venezia Giulia (Ponte Rosso). However, in other regions of Italy, there is great interest in eco-industrial parks, and many policymakers encourage their creation (Tessitore et al. 2014). The case study of Ponte Rosso was chosen as a starting point for the study because of its good inter-company connectivity and contribution to the local economy and society in the region.

Regardless of the industrial symbiosis in the Friuli Venezia Giulia Autonomous Region, Article 58 of the FVG Regional Law of 2015 on the reform of industrial policies provides critical guidelines for the financing of supply chain projects through (1) the establishment of industrial networks; (2) the organisation and integration of phases of the production cycle and supply actions; (3) the distribution of resources, knowledge and activities; (4) the exchange of the work cycle and the use of renewable energy sources together with industrial symbiosis projects and projects aimed at sustainable flexibility of goods, and (5) the development of combined eco-innovations related to the prevention of waste production.

The »Consortium for the Economic Development of Local Enterprises and Industries – Ponte Rosso, Tagliamento«, based in San Vito al Tagliamento, whose current name is Consortium, was established on October 2nd, 2017, by merging the »Consortium for the Industrial Development Zone of Ponte Rosso« and the »Consortium for the Industrial, Economic and Social Development« of the Spilimbergo area. The new entity, the result of the restructuring operations referred to in LR 3/15 »Rilancimpresa FVG«, manages the industrial areas of Ponte Rosso, the northern industrial area of Spilimbergo and the San Vito al Tagliamento craft area (Daddi, Tessitore and Testa 2015).

An eco-industrial park Ponte Rosso manages part of the technical, administrative, and maintenance services in the Tabina craft area in the Valvasone Arzene municipality (Tessitore et al. 2015). It was launched in 2015 through an agreement with the city and includes 224 companies covering an area of almost 570 ha and employing about 5,300 people. The reference area of the companies extends from Castelnovo to Pravisdomini, with 65,000 inhabitants (Daddi, Tessitore and Testa 2015).

Ponte Rosso also has combined production facilities, self-generated electricity and heat distribution facilities, and a railway connecting it to the national grid. In addition, the consortium also monitors several key local environmental performance indicators (Daddi et al. 2015). The eco-industrial park also includes a wastewater treatment plant that complies with emission limits. One of Ponte Rosso's main activities is the acquisition of non-infrastructure land for conversion into large-scale industrial settlements. Consulting services provided under contracts with third parties include services that can lead to greater environmental sustainability, such as quality, environmental and safety consulting. Ponte Rosso is divided into five industrial areas, as shown in Table 1.

In 2018–2020, Ponte Rosso's commitment to infrastructures amounted to 8.444 million EUR, of which 5.251 million EUR was the regional contribution (Conzorzio … 2020). In the 2020–2021 period, the main activities of the Ponte Rosso were to promote employment, and economic growth and to increase the attractiveness of new industrial and artisanal productions. The analysis of companies in the areas of expertise shows that the number of companies with less than ten employees will increase up to 51% of the total in 2020 (compared to 48.9% in 2019) (Conzorzio … 2022).

Table 1: Available detailed data on the infrastructures of Ponte Rosso from 2021 and 2022.

DIMENSIONS	ZIPR	ZA	TABINA	ZIN	ZAPR	TOTAL
SURFACE in 2022 (ha)	372	11	60	112	11.5	566.5
FIRMS in 2022 (no.)	112	19	21	37	13	202
EMPLOYEES in 2022 including employees from rental businesses, companies, kindergartens and canteens (no.)	3,459	104	669	517	167	4,916
PRODUCT SECTORS in 2021	Mechanics, glass, construction, plastic, food, wood					
SEWERS in 2021						
• black network (m)	16,880			5,660		22,540
• white network (m)	19,560			6,400		25,960
RAILWAY CONNECTION in 2021 (m)	12,365					12,365
METHANIZATION in 2021 (m)						
• pipelines	15,170			3,300		18,470
• derivations	1,880					1,880
OPTICAL FIBRE in 2021 (m)	14,530			5,330		19,860
PUBLIC LIGHTING in 2021 (m)	9,730	750		5,400		15,880
INTERNAL ROADS in 2021 (m)	21,000	1,000		5,408		27,408
PARKING LOTS in 2021						
• parking spaces (no.)	250			173		423
• heavy vehicle seats (no.)	50			2		52

Ponte Rosso has equipped the industrial area of San Vito al Tagliamento with environmental protection devices and cameras that monitor the site and collect information on environmental conditions, especially water issues. However, Ponte Rosso urges for a complete cognitive system of ecological matrices, following a unified framework that will guide further project development. In response to this protection system, an experimental project was created; the Ecologically Equipped Production Area project, which has been carrying out studies and projects for public and private clients since 2007 (Brunelli and Buoncompagni 2012), providing expert support throughout the process of implementation and qualification of production areas.

It is evident that Ponte Rosso is following the corporate guidelines for the future regarding environmental issues: Strengthen the image in the region through the needs of the companies; improve and disseminate the management systems; more efficient documentation and implementation of appropriate measures to prevent possible contamination or pollution in the region; Compliance with the regulations and laws applicable to the activities of Ponte Rosso; guarantee environmental standards of the companies for the services provided; raise awareness and involvement of the members of Ponte Rosso to promote and increase respect for the environment, in order to strengthen the environmental culture throughout the territory of the Autonomous Region of Friuli Venezia Giulia (Conzorzio … 2020).

3 Methods

The research goes from the theoretical concept to its implementation with qualitative research, using primary data from interviews and other accessible databases. In the first phase, we also collected all available data from the authors' databases and publicly available sources through literature, online research and reports, using keywords Autonomous Region Friuli Venezia Giulia, sustainable development, eco-industrial park, industrial symbiosis, industrial districts, social geography, networks/collaborations. We then established the protocol for conducting semi-structured interviews with representative stakeholders, consultants, experts, and policymakers (Table 2) in the Autonomous Region of Friuli Venezia Giulia. The qualitative interviews were conducted between June and September 2021. The interviews were conducted with stakeholders from different sectors and organisations (managers, policymakers, artisans, and workers in companies) in the industrial districts. As shown in Table 2, different selected stakeholders were interviewed according to the area/sector in which they operate. This allowed us to get a more comprehensive picture of how to build our dimensional model.

The population of the qualitative analysis consisted of five representatives of local authorities, one representative from the chamber of commerce, two experts from the ICT cluster, four managers from the Ponte Rosso Eco-Industrial Park and three project developers from manufacturing companies in the furniture district, all from the Friuli Venezia Giulia Autonomous Region. We did not focus on one industrial district area but on the entire region. In this way, we tried to avoid informal allies of companies or institutions among the respondents. All interviewees were assured of anonymity. Depending on their proximity, the interviewees selected were personal contacts and connections within the craft companies, the more prominent industries in the industrial districts and the local government. After the initial contact, we snowballed to obtain additional references. The eligible stakeholders were considered so that we could build trust with each of them. We decided to conduct one-on-one interviews. The semi-structural in-depth interviews consisted of 16 questions:

Table 2: Target groups in the Autonomous Region Friuli Venezia Giulia interviewed in 2021.

Number	Economic area	Geographical area	Social area	Environmental area
15 interviews with 16 questions	5 representatives of local authorities (governments, planning and economic development), 1 representative of the Chamber of Commerce from Trieste	2 experts of companies of the Digital Technology Cluster	4 managers of companies of the Industrial Area of Ponte Rosso	3 project developers of companies of the Furniture District

- Operational questions (4) as general questions for an overview of the potential for industrial symbiosis and networking in the Region Friuli Venezia Giulia: organisational structure; sustainable perspectives, goals, regulations, and collaboration; current and future sustainable plans for the area (location); benefits of their existing location.
- From an institutional perspective (3 questions), the survey asked about the legislative approach to waste recycling, factors influencing the successful implementation of sustainable projects, and opinions about regional efforts to reduce waste products.
- From the cognitive framework perspective (3 questions), we asked about the attitudes toward the relationships they currently have with other businesses (if any) that incorporate sustainability measures and networks; whether these relationships involve the exchange of reclaimed products; the potential of human capital in the region.
- From the perspective of the networks, we asked them about cooperation between existing industries in the area/site, general attitudes toward formal and informal cooperation, the importance of trust, the degree of trust among stakeholders, suggestions for improving the process of industrial symbiosis within industrial districts, and their critical thoughts about the improvements achieved (6 questions).

Upon completion of the interviews, we selected and hand-transcribed the primary data and presented them as the final interpretation of the research.

Our preliminary research questions were: »why and how do companies not develop the industrial symbiosis approach within industrial districts despite geographic proximity and organisational and environmental impacts?« And »why is there only one case of industrial symbiosis, although the synergies between stakeholders in this region seem to be very high?«

Following the empirical research (interviews), our preliminary analysis can be presented as a model based on the perception of the current situation in the Friuli Venezia Giulia region. This model refers (as a help) to (1) the geographical-organizational area of businesses, (2) the geographic area, and (3) the social area, as shown in Figure 1. The model could foster, improve or (re)build old/new collaborations within industrial districts in the region.

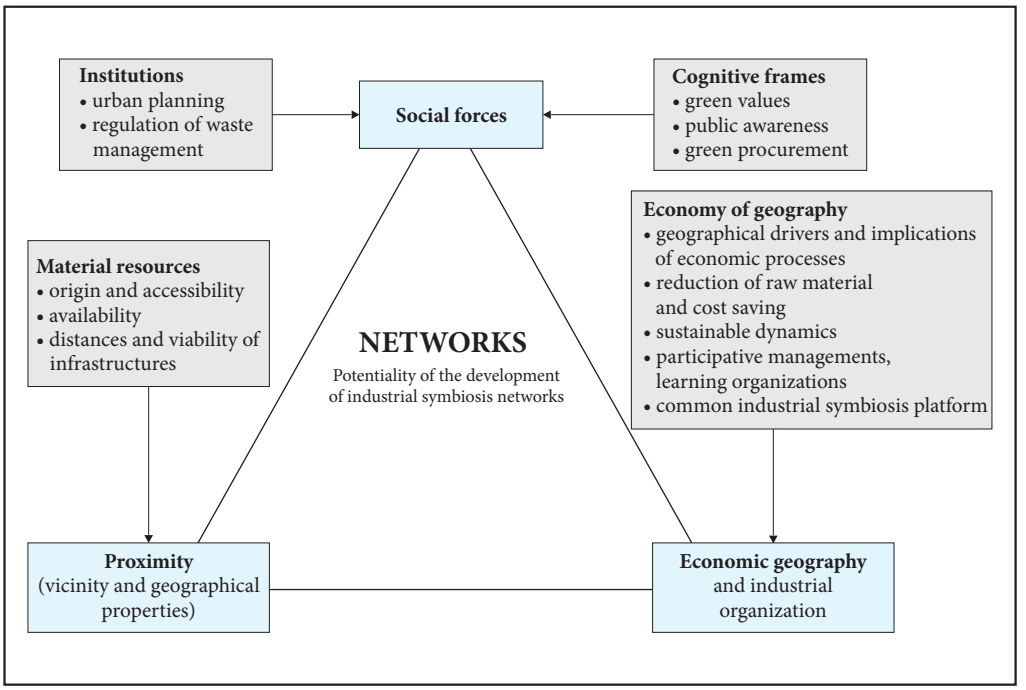

Figure 1: The proposed model of critical drivers, enablers, and barriers for realising potential industrial symbiosis within industrial districts.

4 Results and discussion

The number of small and medium enterprises and a large number of craft businesses increased enormously in recent years, despite the Covid-19 pandemic (as shared a common opinion by different interviewees). These new entrepreneurs are mainly young people under the age of 30, who developed their idea in a start-up and established their businesses with an awareness of the sustainable market and the Triple-R (Reduce, Reuse and Recycle) waste hierarchy. Among them, there are strong social, cultural and organisational links, but not so much with the larger and older industrial companies in the industrial districts. In any case, these young entrepreneurs are engaged in the tertiary sector and in research. One of the local authorities interviewed stated that this problem is worrying for the demographic and socio-economic dynamics. The Friuli Venezia Giulia region is a crossroads of the most developed environmental and business systems for the development of a sustainable industry. On the other hand, there is a risk that the already strong globalisation forces could hinder the model of industrial symbiosis in the industrial districts.

As the interviewee from a smaller company in the furniture industrial district stated: »Efforts to reduce CO_2 emissions, water consumption and waste products in the Friuli Venezia Giulia region are not prevalent in the industry itself, but the issue is more acknowledged than in the past, especially among the larger companies in the industrial districts, that show interest in sustainable technology with their resources«. As we learned from the personal meetings, the attitude of included stakeholders in the research (especially managers and policymakers) is currently not so much focused on sustainability measures. There is still not enough sharing of information and knowledge about the positive effects of the industrial symbiosis approach. Especially in the relationships among industrial districts.

The interviewees agree that a lot of human capital inclined to the industrial symbiosis approach is already present in the Friuli Venezia Giulia region. Key technologies and intermediaries for industrial symbiosis ideation and implementation are already at a reasonable level, and the necessary financial resources are available (thanks to the recent decisions of the European Commission). As for the cooperation of the existing industrial districts, the knowledge of the importance of sustainability is the basis for further development. Unfortunately, environmental improvements are expensive, so that smaller craft companies, for example, cannot afford them.

Some industrial districts are willing to collaborate to strengthen ties and adopt emissions reduction technologies, but only if other companies within the industrial community do the same. »The only and surest way to create a shared sustainable network for companies inside industrial districts is to set the stage for such upward alignment,« said one public official.

All respondents agreed on this: »When it comes to building new cooperation, trust is key« – but as we can see from responses, in the business world everyone tends to think formally about their own business. Therefore, the problem of cooperation and trust is solved through cooperation agreements.

Two of the respondents indicated that they have informal business collaborations on a personal level. Still, they stated that most companies prefer formal relationships to avoid brain drain and uncontrolled exchanges. The final statements from the interviews show that the »fiduciary« collaborations within the industrial districts in the Friuli Venezia Giulia region are not at the highest level. Regardless the reduction, reuse, and recycling of waste and environmental resources in industrial communities are still governed by formal contracts within industrial symbiosis in the region. Many stakeholders/interviewees agree that »right now there is no willingness to collaborate in different ways as they have for decades (as an industrial district). We also see this as a barrier to the development of greater synergies in the environment and geography, which is perhaps the best case for excellent industrial symbiosis in the region.

Based on the Friuli Venezia Giulia region case study, this article identifies some key issues to be considered for future industrial symbiosis linkages in terms of the policies and methods needed to achieve the objectives of attention to the entire chain of stakeholders involved in industrial districts. We have not thinned out any company described in the methods section, but we have presented and interpreted the main coded findings.

From the qualitative research, we can highlight some points. These include, for example, (1) inadequately prepared project proposals for funding industrial symbiosis initiatives (regional, national, international) and (2) a lack of regulations that hinder industrial symbiosis initiatives in the region. It could also be (3) the dilemma of the individual company within the industrial district as to what is »waste or non-waste« and (4) »by-products or not«; (5) a lack of communication and understanding by local authorities, (6)

end-of-waste regulations that conflict with other regulations (e.g., registrations, evaluations, authorisation and restrictions of chemicals (REACH) regulations in the region), (7) the market and labour situation, and (8) the behaviour of the management of an individual company.

In our preliminary analysis through the interviews, we encountered a contradiction. On the one hand, companies tend to open up to the public and cooperate with other stakeholders, which includes symbiotic links. They are willing to be part of a network with the principles of industrial symbiosis and sharing inputs and outputs with other neighbouring industries. On the other hand, the difficulties in creating this network from the company's point of view are persistent problems with human resources. The »rules of the game« are strict and rather old. Some modern technologies can provide exciting solutions but cannot be used freely without certification. For example, in one company, the residues from steel refining are processed to recover precious materials, and these »residues« are considered industrial waste. They must comply with precise and strict environmental regulations.

The proposed model (Figure 1) captures the geographic, social and economic impacts (triple bottom line), focusing on the social aspects. At the same time, the relevant literature for the Friuli Venezia Giulia region does not sufficiently address this gap and does not recognise the role of the social domain in industrial districts. There is little understanding of how social applications function and how they influence development and processes within industrial communities. Recommendations and lessons were drawn from the operational case of the Ponte Rosso industrial area, which can serve as a model for the Friuli Venezia Giulia region. Primary data were also collected through face-to-face interviews with the concept indicators presented in Figure 1 and with municipal, provincial and regional authorities (Table 2) that support our analysis in order to triangulate the material obtained and validate our findings.

Proximity and geographic properties in the model (Figure 1) refer to the geographic accessibility of material resources and the proximity of properties: origin and accessibility of material resources, availability of material resources and distances and carrying capacity of infrastructures. Assets are determined by the diversity of industries, location, core businesses, and the presence of water. As distances between industries increase, operating costs increase, making short physical spaces extremely important for minimising transmission costs.

In the economic geography and its industrial organisations in the Friuli Venezia Giulia, industrial districts themselves, following the rediscovery of Marshall's theories (see the Introduction chapter), emphasise the economy and the revision of the territory as a territorial society (and unit of analysis). In this context, we consider the geographic drivers and impacts of economic processes, cost savings, sustainable dynamics, and participatory management or learning organisations. Common platforms (e.g., shared online bases, centres) can help different companies/industries come together and share common ideas to build networks between companies. It is essential to involve institutions or external agencies (e.g., research institutes and universities) in linking the social platform of the industrial district. This enables serious relationships, trust, easier information sharing, and symbiotic development. In addition, the participatory dialogue between industries promotes organisation and facilitates collaborations.

In this case, the conventional view of economic geography focuses on the idyllic establishment of economic activities, such as significant transportation costs (Sforzi 2002). The approach focuses on industrial structures and regional revenue intensity (e.g. merging with other companies to form a single production process or joining an established local society; Sforzi 2002). It should be remembered that the typical north-eastern Italian industrial districts are of spontaneous (historical-local) origin. At the same time, the Ponte Rosso Eco-Industrial Park is a planned industrial area that either attracts companies from other places or initiates new sustainable initiatives.

The social forces we consider from Beckert's (2010) theory are:

- institutions (local urban planning, waste management regulations, laws, the central concern for law, the formal mechanism for policy rule-making and enforcement),
- cognitive frames (green values, public awareness and green procurement, social interaction, meaning-making technologies, and selective strategic opportunities for reflection and learning), and
- networks (such as individuals or organisations and a set of dyadic ties between these actors), which are not the only means of solving coordination problems in market domains but play an essential role in defining the networks of the industrial district (Džajić Uršič 2020).

Local urban planning is a design of the conditions for issuing, building, permits and defining the general land use, protection and use of the environment, public welfare and design of the urban environment.

This includes air, water, the infrastructure of urban areas, transport, communication and distribution networks (Džajić Uršič 2020).

From a scientific point of view, the added value of the article is to increase the possible realisation of industrial symbiosis within the existing industrial districts specialised in »Made in Italy«; nevertheless, the benefits of this research could: (1) increase the number of existing synergies in the Region Friuli Venezia Giulia, which is the closest Italian region to the Upper Adriatic–Central European border area and geographically crucial for Slovenia. (2) The proximity to this region affects the mutual economic, cultural and social benefits for both countries (Slovenia-Italy). (3) The next advantage we can see is raising awareness of the possible development of industrial symbiosis within industrial districts or cross-border companies.

However, as mentioned above, the reader should interpret the study with caution, as it is an exploratory, qualitative study that may prevent the generalisation of interpretation. Future research could improve this study by increasing the sample size, comparing it to other Italian regions, or using other approaches. A more in-depth analysis of the industrial ecology, industrial symbiosis, and industrial synergies is particularly important in the Friuli Venezia Giulia region because of the support provided by the EU and the Italian Government.

5 Conclusion

In the course of the research, it was found that industrial symbiosis is related to the companies of the industrial district in both formal and informal relationships. Answering the research questions proved to be quite tricky. The answer to the first question, »Why and how do companies not develop sufficient industrial symbiosis within industrial districts despite geographic proximity, organisational and environmental effects?« was that despite geographic proximity, organisational and environmental effects within industrial districts, companies do not develop sufficiently solid trust to be defined as an industrial symbiosis network. The answer may lie in the fact that companies have some extra-professional activities and relatively moderate social connections, that limit the space for developing deeper collaborations/ industrial symbiosis networks and mutual trust. As mentioned above, trust is the biggest obstacle to the development of industrial areas into industrial symbioses in the Friuli Venezia Giulia region. It is also a consequence of the lack of strategies, corporate values and awareness for sustainable development. Ascani (2020) mentioned that the application of the principles of industrial symbiosis supports and develops the local environment and economy, with inevitable barriers such as: finding the right company, technological gap, quantities and innovations not available in the immediate geographical proximity of the companies, and with the obvious exception of waste heat.

Regarding the second research question, »Why is there only (we summarise it in a single case, even if many stakeholders are involved) a case of industrial symbiosis, although it seems that the synergies between the stakeholders in this region are high?« As indicated by the research results, the authors agreed that the role of industrial synergies in waste treatment tends to be underestimated.

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TOURIST MOTIVATION FOR SLOW TRAVEL: A CASE STUDY OF THE VOJVODINA REGION, SERBIA

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Outstanding example of rural tourism in Vojvodina, Brkin salaš, Čenej.

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Tourist motivation for slow travel: A case study of the Vojvodina Region, Serbia

ABSTRACT: Slow tourism is a type of alternative tourism that promotes the tourist experience by slowing down the pace, protecting the environment and improving of the tourist experience quality by engaging tourists with the place. It is a new idea that is gaining acceptance worldwide. This study is a reflection on how this type of tourism might grow in Vojvodina. The first goal of this study was to examine the characteristics of tourists who visited Vojvodina and to examine which destinations in Vojvodina are the most visited. Finally, the primary objective of the article was to investigate the motives travelers choose to travel to Vojvodina. Based on the research data of 243 participants who visited destinations in Vojvodina, two factors that motivate tourists (research and leisure) were identified, using the Exploratory Factor Analysis. Future studies on this subject in the surrounding countries can take advantage of the research methodology.

KEY WORDS: slow tourism, tourist motivation, Vojvodina, Serbia, Exploratory Factor Analysis

Motivacija turistov za počasna potovanja: Primer Vojvodine, Srbija

POVZETEK: Počasni turizem je alternativna vrsta turizma, ki postaja vse bolj sprejeta po vsem svetu. Spodbuja turistične izkušnje z upočasnitvijo tempa potovanja, varovanjem okolja in izboljšanjem kakovosti turistične izkušnje z vključevanjem turistov v kraj. Raziskava nudi razmislek o tem, kako spodbujati to vrsto turizma v Vojvodini. Prvi cilj te raziskave je proučiti značilnosti turistov, ki so obiskali Vojvodino in ugotoviti, katere destinacije so najbolj obiskane. Glavni cilj članka pa je raziskati motive popotnikov za potovanje v Vojvodino. Na podlagi podatkov o 243 udeležencih sta bila z uporabo raziskovalne faktorske analize identificirana dva ključna dejavnika, ki motivirata turiste za potovanje v Vojvodino: raziskovanje in prosti čas. Metodologija, ki je bila uporabljena v tej raziskavi, je prenosljiva in jo je možno uporabiti tudi v drugih raziskavah na to temo.

KLJUČNE BESEDE: počasni turizem, motivacija za potovanje, Vojvodina, Srbija, raziskovalna faktorska analiza

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1 Introduction

Modern travelers have been seeking out fresh, high-quality experiences in recent years by engaging in new, alternative types of travel (Moore 2012; Moira, Milonopoulos and Kondoudaki 2017). Slow tourism is a form of alternative tourism that promotes tourism experiences, travel at a slow pace, preserving the environment and improving the quality of the tourism experience, as well as association with the destination. The concept of slow tourism emerged from the new needs of tourists to slow down the pace of life and travel (Conway and Timms 2010; Heitmann, Robinson and Povey 2011; Meng and Choi 2016; Moira, Milonopoulos and Kondoudaki 2017). Dickinson and Lumsdon (2010) define slow tourism as a conceptual framework that includes tourists travelling 'slower' and closer to home destination while staying longer at a selected destination and using sustainable and local transportation, consuming food that is specific to the place they are visiting. According to Gardner (2009) and Heitmann, Robinson and Povey (2011), slow tourism is the antithesis of mass tourism and a reaction against the fast-paced lifestyle of today. As a result, it is a new tourist niche, or a thorough travel strategy (Serdane 2017). The character of slow tourism as a relatively new form of tourism is increasingly present in the destination planning literature and in the tourism market, as well as in advertising in general (Valls et al. 2019), so it provides researchers with much room forfuture research. So far, the focus of slow tourism research has been mainly on defining this concept in theory. Several studies conducted on this topic (Robbins and Cho 2012; Oh, Assaf and Baloglu 2016; Özdemir and Çelebi 2018) dealt with determining the key motives that lead tourists to slow tourism. Research has been conducted from the aspect of push and pull factors, as well as from the aspect of goal-directed behavior (Oh, Assaf and Baloglu 2016). In Serbia, research on the topic of slow tourism is very scarce, and is in development (Đuranović et al. 2019). Slow tourism in some European countries, such as Italy and Spain, offers an extremely wide range of offers and is believed to have an increasing influence on the tourism market over time (Brovelli et al. 2015; Hernández-Mogollón et al. 2017; Balletto et al. 2019; Valls et al. 2019; Balletto et al. 2020). The potential and importance of the development of slow tourism has been also recognized by the European Union. Namely, in 2019, the project »Mediterranean as an innovative, integral and unique destination for slow tourism initiatives« was launched (*https://www.enicbcmed.eu/projects/med-pearls*). Therefore, this article is important for trying to understanding the development of slow tourism concept and studies possible benefits for the development of tourism, with reference to Vojvodina, which will be presented as a case study.

Although slow tourism is a relatively new, numerous studies have demonstrated the connection between rural tourism and slow tourism as well as how slow tourism is perceived in rural locations (Noor, Nair and Mura 2011; Noor, Nair and Mura 2016; Farhadi Uonaki, Rabani and Khorasani 2022). Also, slow tourism is often linked to the contexts of sustainable and ecotourism (Conway and Timms, 2012; Dodds 2012; Svärd 2013; Serdane 2017; Pécsek 2018).

Vojvodina is a region that is well suited for the growth of rural tourism based on its natural and cultural features (Košić 2009; Demirović 2016; Demirović et al. 2019), and a rural location with a slow way of life might potentially be viewed as an avenue for slow tourism. So, although slow tourism can be associated with rural tourism, it can be said that Vojvodina, in addition to the development of rural tourism, has significant potential for the development of a new type of tourism, slow tourism.

Aim of the article is to define the characteristics of visitors who travel to Vojvodina's destinations and to identify which destinations attract them, in order to relate that the respondents have the characteristics of tourists who travel slowly. In addition, examining the motives why tourists choose to travel to Vojvodina and which ones stand out among them is the study's second and primary objective.

2 Literature review

2.1 Slow tourism concept

Slow tourism is new tourist niche or an overall approach to traveling (Serdane 2017), and is a relatively new form of tourism (Valls et al. 2019). Although the number of academic papers on the topic of slow tourism is growing from year to year (Mavric, Öğretmenoğlu and Akova 2021) and there are numerous definitions none is complete and precise (Oh, Assaf and Baloglu 2016; Valls et al. 2019). Although the concept of slow

tourism is still in its infancy it should be allowed to grow without limitations and definitions (Lumsdon and McGrath 2011). Dickinson and Lumsdon (2010, 1–2) define slow tourism as »a conceptual framework that involves people who 'travel to destinations more slowly overland, stay longer and travel less' and who incorporate travel to a destination as itself an experience and, once at the destination, engage with local transport options and 'slow food and beverage,' take time to explore local history and culture, and support the environment«. Also, these tourists enjoy local culture and sights, consume authentic local cuisine and mostly use local means of transport. Numerous authors have confirmed the provided definitions in many different ways. According to Pécsek (2018), sustainable tourism, which promotes sustainable social, economic, and environmental development of places, is the foundation of slow tourism. Several authors emphasized the importance of slow tourism from the perspective of environmental protection and environmental sustainability (Matos 2004; Conway and Timms 2010; Dickinson and Lumsdon 2010; Lumsdon and McGrath 2011; Hall 2011; Meng and Choi 2016; Chhabra 2020). Recently, the authors began to deal with slow tourism as a form of personal satisfaction and well-being (Meng and Choi 2016; Oh, Assaf and Baloglu 2016; Shang, Qiao and Chen 2020). Also, the importance for slowness was recognized (Heitmann, Robinson and Povey 2011; Lumsdon and McGrath 2011) which can be observed in various areas, such as transportation, accommodation in small capacity pensions, consuming local food that respects the principles of slow food, or in inclusion in local culture and tradition (Babou and Callot 2009; Aksöz and Bâc 2019). Additionally, some authors (Caffyn 2012; Heitmann, Robinson and Povey 2011; Losada and Mota 2019) dealt with this issue from the aspect of length and quality of stay at the destination. The same authors state that slow tourism aims to reduce the number of frequent trips, and thus encourages tourists to stay at the destinations longer. This would lead to tourists spending more time on one destination and during that time getting to know it thoroughly, its culture, tradition, as well as everything local that is produced and sold in it (Yurtseven and Kaya 2011; Caffyn 2012).

In this article, slow tourism is defined as a type of tourism in which travelers indicate their intention to have high-quality experiences while traveling by learning about the local people's culture, history, traditions, and gastronomy. Additionally, tourists that partake in slow tourism explore at their own speed without having to a set itinerary or time-based constraints. Staying in places with a rural, cultural, or sustainable ambiance is referred to as slow tourism. This means that slow tourism by its characteristics favors rural areas, areas rich in cultural values but not overpopulated, and areas rich in natural potential.

2.2 Tourist motivation

Diverse motives emerge as a result of the redirection of tourist movements from mass tourism to special forms of tourism, which are the triggers of tourist movements (Đuranović et al. 2019). Slow tourism is considered an overall approach to tourism, which appeared as a reaction to the fast pace of travel (mass tourism), and is its opposite (Honore 2005; Dickinson and Lumsdon 2010; Dickinson et al. 2010; Lumsdon and McGrath 2011; Timms and Conway 2012; Groenendaal 2012). Also, Matos (2004) states that slow tourism is the antithesis of speed, and Richards (2012) mentions it as the antithesis of a busy life. Therefore, it can be concluded that any type of tourism that is approached in a slow way, and that does not represent mass tourism, can be called slow tourism (Serdane 2017).

Understanding motivation is essential for understanding the decision-making process and determining why tourists prefer slow travel (Jensen 2013; Özdemir and Çelebi 2018). For many years, tourist motivation has been a very important segment of tourism research (Huang 2010). Since slow tourism is a relatively new type of travel, scholars have mostly concentrated on defining this idea. Few studies have been done on this subject (Robbins and Cho 2012; Oh, Assaf and Baloglu 2016; Özdemir and Çelebi 2018; Đuranović et al. 2019), and previous research on the reasons why visitors engage in slow tourism is extremely limited and is just now beginning to be relevant in the literature. One of the most important aspects of creating higher-quality goods and services at the destination is considering what inspires visitors to choose slow tourism (Özdemir and Çelebi 2018). The topic of motivating tourists to travel slowly concluded that the main motives of tourists for slow travel are related to relaxation, escape from everyday life, searching and discovering new things, self-reflection, and engagement and interaction with locals. Robbins and Cho (2012) were among the first to conduct research on this topic and identified five main topics that drive tourists on slow travel: news, relaxation, social interaction, mode of transportation, and cultural difference. Slow tourism is described as a goal-driven activity in a later article by Oh, Assaf and Baloglu (2016),

which defines six broad motives for slow travel (relaxation, self-reflection, escape, newspaper search, engagement, and discovery). On the other hand, motivation in tourism is most often viewed in the context of push and push factors (Kim, Oh and Jogaratnam 2007; Pearce 2011; Xu and Chan 2016; Wong, Musa and Taha 2017). In addition, Özdemir and Çelebi (2018) leaving their personal mark, introducing a motive related to environmental care and social interaction that are internal (pull) factors.

In the literature, a significant similarity of motivation in slow tourism with motivation in rural tourism can be noticed. Authors who dealt with the topic of motivation in rural tourism (Tsephe and Obono 2013; Demirović et al. 2019), state that the main factors of motivation are related to the desire to escape; enjoyment and relaxation; the search for an unforgettable experience; desire for adventure; the need to learn; discovering nature and observing landscapes; enjoying the changing pace of everyday life; security; the need for pollution-free destinations; accessibility, etc. The biggest difference can be seen in the fact that slow tourism goes a step further in motivating tourists and introduces interaction with the local population (hosts) and local culture as a very important segment that can motivate tourists.

As there are different definitions, there are also different interpretations about whether slow tourism can be presented as an overall approach to tourism, an umbrella brand that includes different types of tourism, or as a special tourism niche (Serdane 2017). Some authors (Woehler 2003; Murayama and Parker 2012; Singh 2012) state slow tourism as an umbrella brand that includes different types of tourism. Precisely from this point of view, it can be explained that slow tourism has a great similarity of motives with rural tourism.

3 Methods

3.1 Case study area

The Autonomous Province of Vojvodina is located in the northern part of the Republic of Serbia. Geographically, the territory of Vojvodina belongs to the southern part of Central Europe and also includes the southern and southeastern part of the Pannonian Plain (Petrović 2014).

3.2 Research design

The research was conducted from April to August 2020. An online questionnaire distributed via e-mail and social networks (Facebook, LinkedIn, Instagram) was used as the main tool. Supplementary, 16.5% (41) respondents out of a total of 243 were surveyed in the classic way (pencil and paper).

The questionnaire used in the research consists of 14 questions, both closed and open, systematically divided into three segments. The first segment refers to the socio-demographic characteristics of the respondents. The second segment consists of questions about the frequency of travel and Vojvodina as a destination. In this segment the respondents were asked to list the destinations in Vojvodina that they visited, as well as to state the main reason for visiting the destination. Also, the respondents were asked to indicate with whom they traveled and whether they stayed at one or more destinations during the trip. The third segment refers to the evaluation of the degree of agreement/disagreement with statements related to travel motives. The research instrument was designed based on 14 factors of motivation defined by Oh, Assaf and Baloglu (2016). Factors of motivation were used to measure the importance of each motive individually for tourists who visited slow destinations in Vojvodina. In that segment, a five-point Likert scale was used (1 – completely disagree, 2 – partially disagree, 3 – not sure, 4 – partially agree, 5 – completely agree).

Data collected by the research were processed via IBM SPSS 17 (Exploratory Factor Analysis, descriptive statistical analysis, t-test, ANOVA test, correlation analysis).

3.3 Study sample

For the purposes of the research, tourists who have ever visited Vojvodina were asked to fill out a questionnaire. The sample consisted of a total of 243 respondents, and their socio-demographic characteristics are shown in Table 1.

Table 1: Socio-demographic characteristics of the respondents (n = 243).

Characteristics	Percentage (%)
Gender	
Male	28.4
Female	71.6
Education	
Primary school	/
High school	23.9
Faculty	46.9
Master studies	24.7
PhD studies	4.5
Monthly income	
Below average	31.3
Average income	26.3
Above average	26.7
No income	15.6
Age	
< 18 years	1.2
19–0 years	48.1
31–40 years	19.3
41–60 years	28.8
> 61 years	2.5
Type of residence	
Village	10.7
Small town (up to 10,000 inhabitants)	11.5
Medium-size city (10,000-100,000 inhabitants)	25.1
Big city (over 100,000 inhabitants)	52.7
Total	100.0

From Table 1 we can note that the majority of respondents are women (71.6%) with an average age of 19 to 30 years (48.1%). Nearly half of the respondents (46.9%) are university-educated people. As for the monthly income, respondents with average incomes (26.3%) and with incomes above the average (26.7%) have an almost identical share. When it comes to the type of residence, the largest number of respondents come from large cities (52.7%).

4 Results

The respondents stated their habits during the trip. Respondents who visited Vojvodina mostly travel once in a few months (45.3%), most often with a partner/family (54.3%), and during the trip they stay in only one (48.6%) or at most two or three destinations (38.6%), thus leaving time to devote to each location.

Respondents were asked to specify which Vojvodina destination they had visited in order to gain understanding into which locations attract the most tourists and which locations need the greatest attention. The results showed that the most visited destination of slow tourism in Vojvodina is Fruška gora National Park (77.5%), which attracts a large number of tourists with a rich history, nature and proximity to Novi Sad. Immediately after, in second and third place are Nature Park Palić (64.2%), and Sremski Karlovci (62.9%). On the other hand, other destinations were visited by less than half of the respondents, while the least of them (18.9%) visited the Bač Fortress.

That Vojvodina can be a destination of slow tourism, proved the answers of the respondents about the main reasons for visiting this destination (Table 3). As many as 63.8% of respondents cite the need for rest as a reason for arrival, which clearly shows that Vojvodina is an ideal destination for slow tourism, which focuses on travel approaches that will emphasize the quality satisfaction and peace of tourists (Shang, Qiao and Chen 2020).

Table 2: The main reason for visiting the destination of slow tourism in Vojvodina.

Reason for visiting	Percentage (%)
Vacation (need for rest)	63.8
Business	9.1
Visit to a friend/family	20.2
Excursion	3.3
Field teaching	2.1
School excursion	1.6

The main goal of the second segment of the survey was to explore what are the motives that drive respondents to visit one of the destinations in Vojvodina. Therefore, based on motivation factors, exploratory factor analysis was conducted to listed factors, and then a descriptive analysis of motivation factors was presented which showed which motives were more prominent than others. Finally, the ponential diference was in the motives of the respondents' socio-demographic characteristics.

4.1 Exploratory factor analysis

The scale of motivation of the respondents showed high statistical significance ($\alpha = .842$). To isolate motivation factors, a principal component exploratory factor analysis (EFA) was performed, with Promax rotation and Kaiser normalization. The Kaiser-Meier-Olkin (KMO) sampling adequacy measure was satisfactory 0.933 and the Bartlett test confirmed the adequacy of the factor analysis ($\chi^2 = 3049.7$, $df = 91$, $p < 0.01$). Such results indicate that factor analysis is suitable for these data (Tabachnick, Fidell and Ullman 2007). Two significant factors stood out with a total of 70.29% of the variance explained. Factor 1 (9 items) refers to motives that include research at the destination and learning new things, while factor 2 (5 items) refers to motives for leisure or relaxation at the destination itself. These two factors are shown in Table 3.

Only two driving motives (research and leisure) stood out in our research, as opposed to the study of Oh, Assaf and Baloglu (2016) from which the scale was derived. Previous research identified six motives (relaxation, self-reflection, escape, discovery, engagement, and learning), which was not the case in our study.

After separating the factors, a descriptive analysis of each motivation factor individually is presented (Table 4). The goal was to identify the elements that motivate respondents to travel to Vojvodina the most.

Table 3: Rotated matrix of components (motives).

Motives	Research	Leisure
	$\alpha = 0.927$	$\alpha = 0.938$
I wanted to experience an adventure.	.933	
I wanted to have the opportunity to meet new people and do some new things.	.874	
I wanted to learn more about something new.	.823	
I wanted to expand my knowledge of what the destination I visited could offer.	.813	
I wanted to experience different things than usual on the trip.	.791	
I wanted to fit in perfectly with the local culture.	.789	
I wanted to develop my personal and spiritual values.	.537	
I wanted to feel that I belonged completely to nature.	.533	
I wanted to think more about myself.	.432	
I wanted to escape the hustle and bustle of my daily life.		.953
I wanted to avoid the pressure and stress of my daily life.		.951
I wanted to relax my mind on the journey.		.896
I wanted to experience peace / harmony.		.836
I wanted to get away from the daily routine.		.808

Table 4: Descriptive statistics of motives.

Factors and items	Mean	Standard deviation
Research	3.7	.9994
I wanted to experience an adventure on this trip.	3.7	1.2796
I wanted to have the opportunity to meet new people and do some new things.	3.7	1.2961
I wanted to learn more about something new.	4.1	1.1598
I wanted to expand my knowledge of what the destination I visited could offer.	4.2	1.1218
I wanted to experience different things than usual on the trip.	3.9	1.2202
I wanted to fit in perfectly with the local culture.	3.5	1.2504
I wanted to develop my personal and spiritual values.	3.5	1.3670
I wanted to feel that I belonged completely to nature.	3.7	1.2843
I wanted to think more about myself.	3.2	1.3147
Leisure	4.2	1.0120
I wanted to escape the hustle and bustle of my daily life.	4.1	1.1651
I wanted to avoid the pressure and stress of my daily life.	4.2	1.1211
I wanted to relax my mind on the journey.	4.3	1.1214
I wanted to experience peace/harmony.	4.1	1.1425
I wanted to get away from the daily routine.	4.3	1.0994

4.2 Factors influencing the motivation of the respondents

In order to determine the potential difference in the motives of the respondents by observing the type of residence from which they come, the monthly income of the respondents and their education, the ANOVA test was conducted.

Observing the type of residence from which they come, the respondents were divided into four categories: 1 – village, 2 – small town, 3 – medium-sized city, 4 – big town. The results are shown in Table 5. Respondents coming from the village are the least interested to research and relax while traveling. This can be explained by the fact that respondents from larger cities have a greater need to escape from urban environments, and also have a greater desire to rest and explore a new environment.

Table 6 reveals that there are statistically significant differences in the respondents' answers for both motives and according to the type of residence of the respondents.

Observing the monthly income of the respondents, they are also divided into four categories: 1 – income below the average, 2 – average income, 3 – income above the average, 4 – no income. The results are shown in Table 7.

Table 5: ANOVA test – the effect of the type of residence of respondents on motivation factors.

Factors	F-value	LSD post-hoc test
Research	5.678**	1 < 3, 4 2 < 4
Relaxation	4.963**	1 < 2, 3, 4

(* $p < 0.05$, ** $p < 0.01$)

Table 6: ANOVA test – the effect of monthly income of respondents on motivation factors.

Factors	F-value	LSD post-hoc test
Research	6.715**	1 < 2, 3, 4
Relaxation	9.446**	1 < 2, 3, 4 2 > 4

(* $p < 0.05$, ** $p < 0.01$)

Table 7: Correlation analysis – age of respondents and motivation factors.

Factors	Age
	Pearson correlation coefficient (r)
Research	.174**
Relaxation	.108

(* $p < 0.05$, ** $p < 0.01$)

There are statistically significant differences for both motivational factors when observing the monthly income of respondents. Namely, respondents who have incomes below the average are less motivated by relaxation and research of destinations in Vojvodina. It is also important to note that respondents with average incomes are more motivated by travel relaxation than non-income respondents.

The obtained results did not show statistically significant differences in motivation depending on the respondent's level of education.

An additional test was performed on motivational factors regarding the age of the respondents. Specifically, a correlation analysis was used to see if the motivation was related to the age of the respondents. The results are shown in Table 7.

The results from the previous table (Table 7) show that the older the respondents, the more they are motivated to go on a trip to explore new destinations and learn new things, discover new people, cultures and the like.

In addition to the ANOVA test and correlation, a T-test was performed to compare respondents' responses by gender in terms of motivation to travel to Vojvodina. The results of the T-test showed that women are the ones who are more motivated by relaxation at rest ($t = -2.023$, $p = .044$), while the same situation is with the research as a motive ($t = -2.842$, $p = .005$).

5 Discussion

The first goal of the research was to determine who are the tourists who visit Vojvodina and, based on their travel habits, to find out if they can be potential tourist who would use slow travel. Based on the results it can be noticed that the respondents fit into the concept of slow tourism that favors more independent than group travel (Cosar and Kozak 2014), advocates for reducing the frequency of travel (Losada and Mota 2019), encouraging tourists to stay longer in one chosen destination to which they dedicate time (Dickinson and Lumsdon 2010; Caffyn 2012). The results of the study by Yurtseven and Kaya (2011), which classified slow tourists and described their habits and found that these habits fully correspond with those of tourists visiting Vojvodina, support the claim that the respondents to this research can be classified as tourists who fit the slow tourism category.

The findings of the most popular tourist destinations are consistent with the research of the Tešin et al. (2020) who in their research found that the Fruška gora National Park and the Palić-Ludaš Nature Park are the most visited ecotourism destinations in Serbia. The findings imply that the most popular and alluring tourist destinations are those that offer a mix of rich cultural history and preserved natural areas, as well as having the necessary infrastructure to handle a particular volume of visitors. The results are encouraging and perfectly align with the slow tourism tenets.

So far, numerous authors have understood and through their work have emphasized the importance of sustainable tourism sustainability (Burns and Bibbings 2009; Gardner 2009; Hall 2011). Ecologically sustainable development is considered an important pillar of the philosophy of slow tourism (Matos 2004), and slow tourism is closely related to ecology and sustainable development (Moira, Mylonopoulos and Kondoudaki 2017), and thus to take into account the trace that tourism leaves in host environment (Meng and Choi 2016; Chhabra 2020). Vojvodina has a lot of potential in terms of natural resources that are protected (Tešin et al. 2020), and this kind of tourism could be the good solution for how tourism is run in the future.

Looking at Table 4 which shows the average values of each motive we notice that all values are above average. The items within factor two stand out, in which all mean values exceed grade 4. In this aspect, it is evident that travelers prioritize leisure and relaxation, which is consistent with research on what drives people to engage in slow tourism (Robbinson and Cho 2012; Oh, Assaf and Baloglu 2016). The average values contain things that are little lower but still above average, as factor one (research).

Differences in the number of respondents according to some of the socio-demographic characteristics were highlighted in terms of place of residence, monetary income, as well as sex of the respondents. Namely, the respondents who live in a village and a small town are less motivated by relaxation, and the desire to explore the destination. Such data show that the respondents from a smaller place do not have such a pronounced need to retreat from the city lifestyle and the stress of everyday life, which is present in larger cities. Thus, a conclusion is reached that money and the amount of monthly income are certainly the factors that most often influence the motivation and decision of tourists to travel or not travel (Jackson 2005). Additionally, it is very likely that are people who earn more money feel more pressure and stress out at work and require more rest. Additionally, the results of the t-test might be explained by the fact that older persons have more free time because they have fewer obligations in terms of employment and family (Nyaupane and Andereck 2008).

Slow tourism might be a viable option for the growth of tourism in rural regions like Vojvodina because it is closely related to rural tourism. It is necessary to further revitalize regions with significant untapped potential using innovative sustainable ideas, such as the idea of slow tourism (Matos 2004).

As the number of works on slow tourism increases from year to year (Mavric et al. 2021), and the concept of slow tourism becomes important, this topic requires further and more detailed academic studies in order to spread awareness of this important topic. The importance of this topic is reflected in the fact that slow tourism provides opportunities for a more sustainable and green form of destination tourism, and the concept of »slowing down« can be applied as an ideal marketing strategy in destinations (Park and Lee 2019). The results of this research can be significant both for Vojvodina and for neighboring European countries that have similar or the same tourism potentials, which are reflected in rural areas and preserved nature. Also, results can contribute to a better understanding of the topic of slow tourism and the potential of Vojvodina as a tourist destination, which in the future could be suitable as a destination of slow tourism. It is important to emphasize that slow tourism represents the future of tourism (Conway and Timms 2010) and that the development of this type of tourism would achieve many benefits for both destinations and local communities (Conway and Timms 2012).

6 Conclusion

Tourists who visited one of the destinations in Vojvodina fit into the concept of slow tourism. The topic of slow tourism in Vojvodina is not sufficiently researched. Therefore, there is no knowledge of what benefits this type of tourism can bring to communities and destinations. Despite the natural and cultural wealth, as well as all the characteristics of many places throughout Vojvodina that have a potential for the development of this type of tourism, tourists have shown that the most visited are precisely those destinations that are known to everyone. The main driving motives for travelers' decisions to travel slowly in Vojvodina were identified as leisure and research. The observed results are consistent with the authors Antić, Vujko and Gajić (2015) research, which found that tourists prefer to remain in rural locations to escape the stress of daily life. This research could present the beginning of research on the topic of slow tourism in the Balkans, which can stimulate further research that can lead to the creation of new tourism products (eg slow tourist routes between European countries).

In the future, it will be essential to concentrate more on emerging forms of tourism, such slow tourism, which can be used as an effective tool for the development of destinations. Due to the growth of sustainable tourism, which supports the sustainable social, economic, and ecological development of the destination, slow tourism can also have a number of benefits for local communities as well as for destinations.

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FLOOD MAPPING BASED ON OPEN-SOURCE REMOTE SENSING DATA USING AN EFFICIENT BAND COMBINATION SYSTEM

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ANGGER PUTRANTO

Flooding in the Tempurejo sub-district, Jember Regency, East Java Province, Indonesia.

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Flood mapping based on open-source remote sensing data using an efficient band combination system

ABSTRACT: Flood mapping is an essential component of planning flood mitigation. The availability of remote sensing data makes rapid flood mapping possible. This article develops an accurate method for rapid flood mapping using satellite imagery. Sentinel-2 imagery was tested by acquiring data before and after a flood event in a lowland area. Flooding extraction was performed using the newly developed Flood Inundation Extraction Index (FIEI) and compared to the Modified Normalized Difference Water Index (MNDWI), the most commonly used index. Based on the choice of threshold, the results are divided into flooded and non-flooded areas. Evaluation of the performance accuracy based on the total and kappa coefficients showed that the FIEI approach is more accurate than the MNDWI approach.

KEY WORDS: rapid flood mapping, Sentinel-2, Modified Normalized Difference Water Index, Flood Inundation Extraction Index, kappa coefficient, accuracy, Indonesia

Kartiranje poplav na podlagi odprtokodnih podatkov daljinskega zaznavanja z učinkovitim sistemom kombiniranih pasov

POVZETEK: Kartiranje poplav je ključno za načrtovanje blažitev njihovih posledic. Razpoložljivi podatki, zajeti z daljinskim zaznavanjem, nam to omogočajo. V članku razvijamo natančno metodo za hitro kartiranje poplav na podlagi satelitskih posnetkov. Posnetke Sentinel-2 smo testirali s podatki pred in po poplavi v nižinskem območju. Poplave smo zaznavali s pomočjo na novo razvitega ekstrakcijskega indeksa najvišjih poplav (FIEI) in ga primerjali s prilagojenim normaliziranim vodnim indeksom (MNDWI), ki je najpogosteje uporabljen indeks v tovrstnih raziskavah. Območja smo glede na izbor določenega praga razdelili na poplavljena in nepoplavljena. Vrednotenje natančnosti rezultatov na podlagi skupnih in kapa koeficientov je pokazalo, da je pristop FIEI natančnejši od pristopa MNDWI.

KLJUČNE BESEDE: hitro kartiranje poplav, Sentinel-2, prilagojen normalizirani vodni indeks, ekstrakcijski indeks najvišjih poplav, kapa koeficient, pravilnost, Indonezija

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1 Introduction

A flood is a natural disaster in which a place is inundated for a specific duration, leading to damage to property and loss of life (Huang and Jin 2020; Mahmood et al. 2021). Floods occur due to heavy rainfall, which increases basin runoff, causing the water levels in municipal drainage, water bodies, and rivers to overflow beyond their capacity (Gašparovič and Klobučar 2021). Accurate mapping of flooded areas is a critical step in flood mitigation. However, the conventional approach to predicting flooded areas takes a long time and cannot provide timely information during disasters (Ferk et al. 2021). Moreover, traditional land observation methods are expensive and time-consuming (Rahman et al. 2019).

Flood mapping can provide near real-time data and readily accessible information to predict flooded areas (Sivanpillai et al. 2021). Satellite remote-sensing technology may provide fast information on flood maps (Chen et al. 2019). Furthermore, the integration of remote sensing data and geographic information systems (GIS) has been developed to map flooded areas (Wang et al. 2002). The integrated method of water body mapping is based on indices and mapping flooded areas (Sarp and Ozcelik 2017; Zhou et al. 2017). The approach has created opportunities for quantitative analysis of disaster events across all geographic and spatial scales, including flood mapping. Remote-sensing technology has been developed to provide fast information needed to produce near real-time predictions of flood maps (Sajjad et al. 2022). The technology makes possible quick action by emergency response agencies during a flood event (Sivanpillai et al. 2021).

Previously, Feyisa et al. (2014) used Landsat TM5 images to compare the Automated Water Extraction Index (AWEI), maximum likelihood (ML), Normalized Difference Water Index (NDWI), and Modified NDWI (MNDWI) methods. These methods were applied to five research locations with varying threshold values (TVs) for each site. The AWEI method showed greater accuracy than NDWI, MNDWI, and ML. Another study attempted to combine synthetic aperture radar (SAR) Sentinel-1 and Sentinel-2 imagery data using the NDWI method to quickly and cheaply predict flooding (Huang and Jin 2020). Fisher et al. (2016) used several indices from Landsat TM, ETM+, and OLI images for mapping flooded areas using the water index (WI). The results showed that the WI_{2015}, WI_{2006}, and $AWEI_{shadow}$ methods had the best accuracy. The kappa and overall coefficients reached 95% to 99%. Sivanpillai et al. (2021) recommended the MNDWI method for predicting flooded areas and also to validate the maps by exploring spectral bands 3 and 12 of Sentinel-2. In addition, the MNDWI method was successfully applied to water areas with a background dominated by built-up land (Sivanpillai et al. 2021).

Flood mapping for complex land cover requires sensitive spectral combinations to detect floods in lowland areas. Niwas et al. (2015) and Ettehadi Osgouei et al. (2019) explained that near-infrared (NIR) waves are suitable for detecting water, and green waves are best for detecting vegetation areas. Mid-infrared (MIR) waves are suitable for detecting open land or built-up areas. Remote sensing technology for rapid flood mapping is needed to determine evacuation priorities and mitigation in flood events. Flooded areas can be extracted on the basis of a certain TV of a selected index. However, each image extracted in several locations has a TV that varies according to the location and time of image acquisition, affecting the resulting accuracy (Feyisa et al. 2014). This indicates a development gap for further research to ensure that the correct TV is adopted for the specific geographical region, image type, and date. Therefore, a new approach is needed to flood mapping with complex land cover. Previous studies using Landsat imagery with the NDWI and MNDWI approach in the Citarum watershed, the Bengawan Solo watershed, and the lowland area of Purworejo, Indonesia, have not yielded satisfactory results (Suwarsono et al. 2013).

Based on the spectral bands used in NDWI and MDWI, this study aims to improve the accuracy by modifying spectral combinations and testing flood thresholds using Sentinel-2 image data. The Flood Inundation Extraction Index (FIEI) approach has been developed to distinguish between flooded and non-flooded areas using a suitable TV for application in multiple locations. The rapid flood mapping developed using remote sensing integrated with GIS aims to determine priorities for handling flood-affected areas.

2 The study area

The study area covers the Tempurejo sub-district (524.46 km^2) in the southern part of Jember Regency, East Java Province, Indonesia. According to the National Disaster Management Agency, flood events in the sub-district often occur at the beginning of the year and repeat annually (https://gis.bnpb.go.id/). The

five flood-prone areas included in the study are the villages of Curahnongko, Curahtakir, Sidodadi, Sanenrejo, and Wonoasri (Figure 1).

On Friday, February 6th, 2021, the five villages in the sub-district experienced one of the most significant floods of the year. This was caused by high-intensity rainfall for three consecutive days starting on 4th February, 2021, with the Tempurejo rain gauge recording 58 mm, 53 mm, and 90 mm. During the event, the discharge of the Sanenrejo and Curahnongko rivers increased dramatically and overflowed into the residential settlements. The flood depth reached two meters and lasted about four to six days. Around 12,000 houses were flooded, seven worship facilities were damaged, and five educational facilities were severely affected.

3 Methods

The image treatment consists of pre-processing, processing, and post-processing. The pre-processing focuses on data collected from the national flood inventory, European Space Agency Sentinel-2 imagery, and digital elevation model (DEM). Sentinel-2 image data were selected before and after the flood event to describe the flooded area. This study uses a National Digital Elevation Model (DEMNAS) at 8.1 m pixel resolution. The DEM is used for watershed delineation. The processing includes overlay, cropping, indices calculation, flooded area extraction, and TV treatment. If an overall accuracy is less than 75% the accuracy has not reached the best model. To reach the best model, it is necessary to re-treat the TV by changing the TV treatment. Meanwhile, post-processing involves accuracy assessment and model analysis to derive the flood map based on the best model, as summarized in the flowchart in Figure 2.

The new method was applied and tested in five villages, and the success rate was assessed using the overall accuracy, kappa coefficients, user accuracy, and producer accuracy. The performance was benchmarked and compared against the MNDWI method, which is reported to have high accuracy in rapid flood mapping (see Section 1).

3.1 Data collection

Table 1 lists the data types used, including the source and function. The flood inventory used for model validation consists of an in-situ field survey and flood data from the Indonesian National Board for Disaster Management (Indonesian: *Badan Nasional Penanggulangan Bencana*, BNPB) website and the social media (Official Instagram @bpbd_kab.jember) around the Jember Regency Disaster Management Board and the newspaper *Akurat.co* (Nurullatifah 2021).

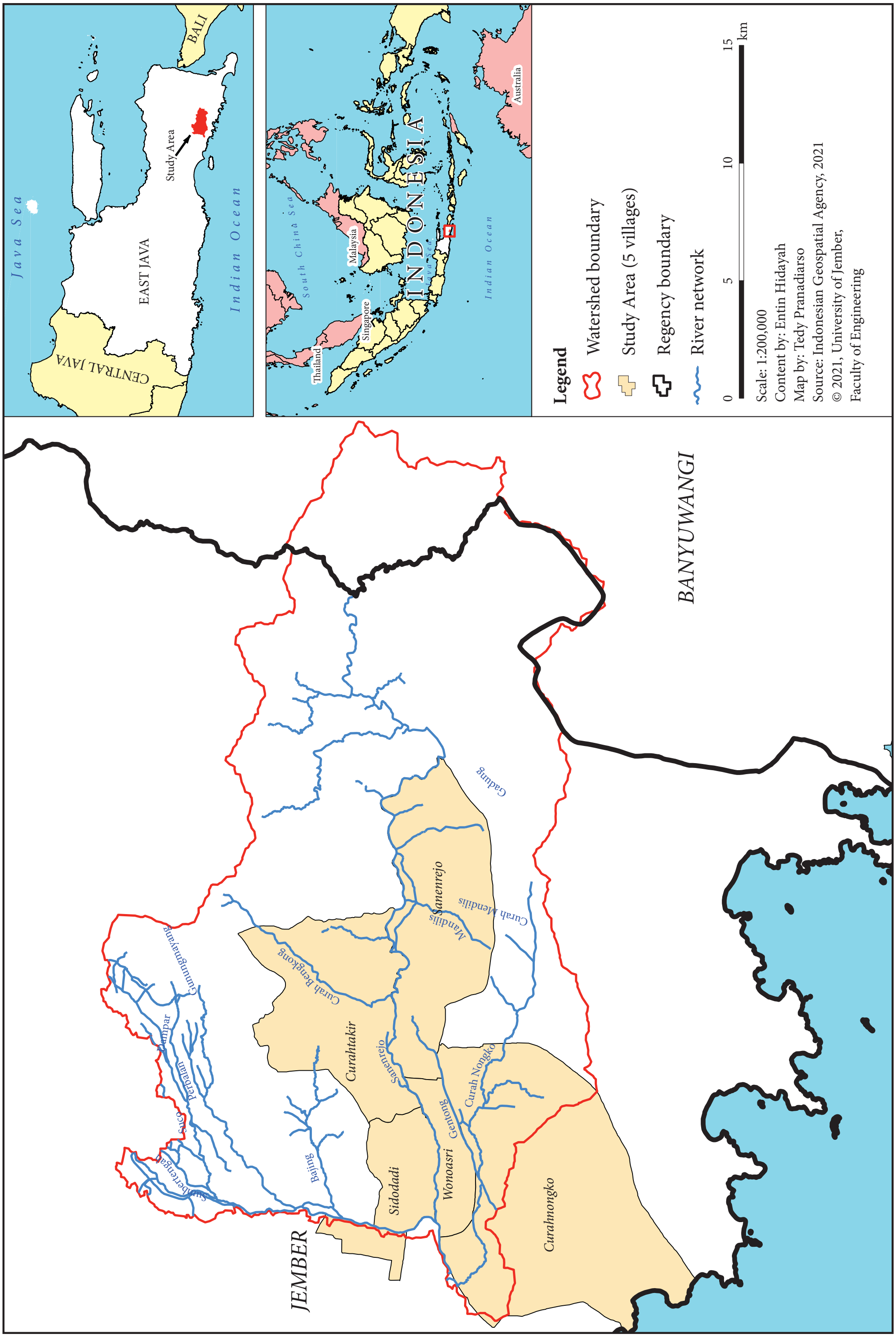
Flood extraction was performed using the Sentinel-2 imagery taken before and after February 5th, 2021. The corresponding satellite images used are January 21st, 2020, and February 9th, 2021, corresponding to before and after the flood event. The flood event inventory data were taken in the field, which excludes permanent water areas. The Sentinel-2 image data used are data before and after the flood incident to compare the flood before and after the incident and determine the flooded area. Pre-flood data are used to determine the location of permanent water bodies. Post-flood data describe the entire site of the flood. The administrative boundary and DEMNAS data were obtained from the Indonesian Geospatial Information Agency (Indonesian: *Badan Informasi Geospasial*, BIG). In addition, the DEM data use the vertical datum EGM2008 with a root mean square error (RMSE) value of 2.79 m and a standard error value of −0.13 m.

3.2 Spectral bands

Table 2 shows the four spectral bands of Sentinel-2 datasets, including the wavelength, spatial resolution, and principal applications (SUHET 2015; Niwas et al. 2015; Bousbih et al. 2019).

Past research using the NDWI (Sentinel-2 bands 3 and 8) and the MNDWI (bands 3 and 12) reported that, for pixel values ranging from −1 to 1, values from 0 to 1 best represent open water (i.e., flooding;

Figure 1: The study area. ► p. 51


Java Sea
BALI
EAST JAVA
CENTRAL JAVA
Study Area
Indian Ocean
INDONESIA
South China Sea
Malaysia
Singapore
Thailand
Australia
Legend
Watershed boundary
Study Area (5 villages)
Regency boundary
River network
0
5
10
15
km
Scale: 1:200,000
Content by: Entin Hidayah
Map by: Tedy Pranadiarso
Source: Indonesian Geospatial Agency, 2021
© 2021, University of Jember,
Faculty of Engineering
BANYUWANGI
JEMBER
Gadung
Sanenrejo
Curah Mendiliis
Mandiliis
Curah Bengkong
Curahtakir
Sanenrejo
Curah Nongko
Gentong
Wonoasri
Sidodadi
Curahnongko
Bajing
Gunungmayang
Pernaum
Sumbertengah

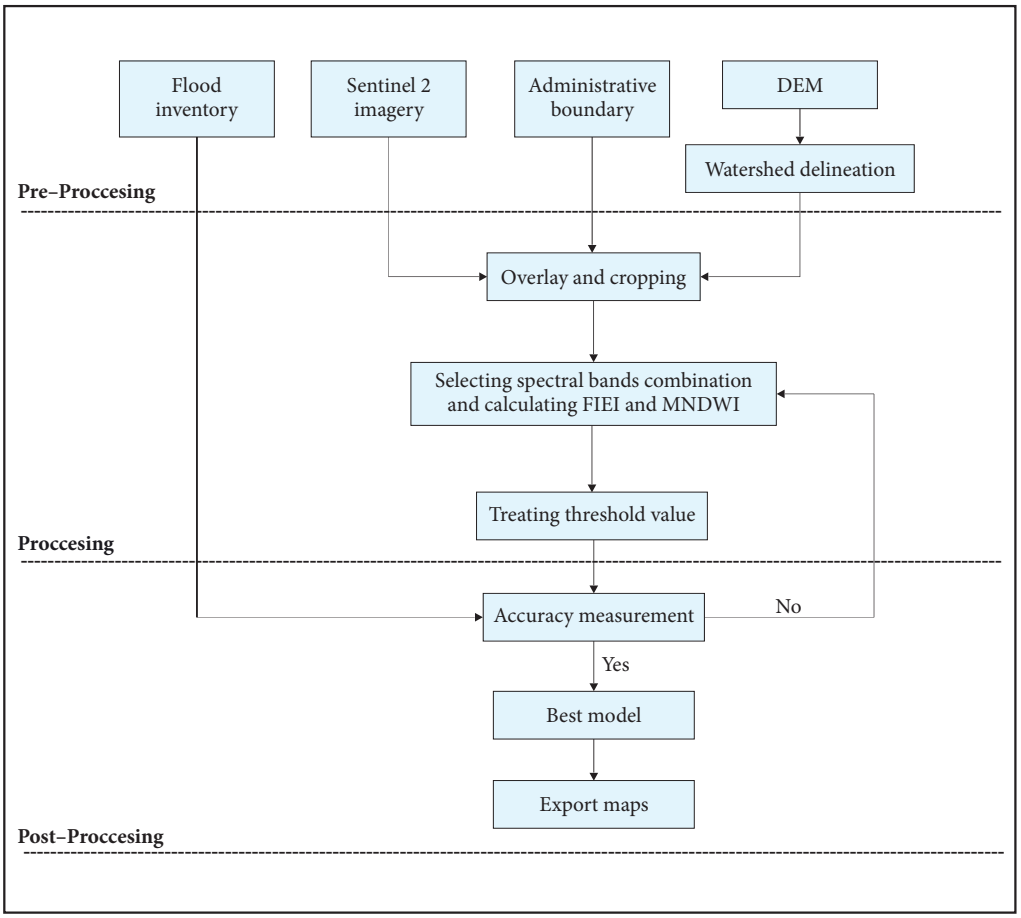


Figure 2: Three-stage methodology flowchart.

Table 1: Data sources.

No.	Data type	Source	Function
1	Flood inventory	• Field survey • Indonesian National Board for Disaster Management (www.gis.bnpb.go.id) • Jember Disaster Management Board (Instagram @BPBD Jember Regency)	Validation of model results
2	Citra Sentinel 2-L1C imagery	Sentinels Scientific Data Hub (https://scihub.copernicus.eu/)	Flooding extraction
3	Administrative boundary	Indonesian Geospatial Information Agency (BIG) (https://tanahair.indonesia.go.id, https://geoservices.big.go.id)	Boundary of villages
4	Digital elevation model (DEM) (resolution = 8.1 × 8.1 m)	Indonesian Geospatial Information Agency (BIG) (https://tanahair.indonesia.go.id)	Delineation of watershed (boundary of study) and river network system

Table 2: Spectral bands of Sentinel-2 L1C imagery (Niwas et al. 2015; SUHET 2015; Bousbih et al. 2019).

No.	Spectral band	Wavelength (nm)	Spatial resolution (m)	Principal applications
1	B03–Green	560	10	Green reflectance by healthy vegetation
2	B08–NIR	842	10	Biomass surveys, water body delineation
3	B11–MIR	1610	20	Vegetation moisture measurement and built-up
4	B12–MIR	2190	20	Hydrothermal mapping, built-up

Xu 2006). However, the soil and terrestrial vegetation properties have a negative value because NIR and MIR reflectance are higher than green. Niwas et al. (2015) and Ettehadi Osgouei et al. (2019) explained that NIR and green waves are suitable for detecting water and vegetation areas. In contrast, MIR waves are suitable for detecting open land or built-up areas. Developing a flood mapping method is necessary by combining the green, NIR, and MIR spectral algorithms available in Sentinel-2 satellite imagery. The algorithm was applied to flood mapping with varied land cover such as vegetation, built-up land, and open water, which requires additional sensitivity to detect water and obtain more accurate mapping.

3.3 The Flood Inundation Extraction Index

The FIEI approach with a combination of Sentinel-2 bands 3, 8, and 11 were expected to provide better results in rapid flood mapping. The combinations were assumed to differentiate the best particular land uses in the study area. The process of flooding extraction and mapping was performed using ArcMap 10.8.2 software.

The new formula can be expressed as:

$$FIEI = \frac{B3 - B8 + B11}{B3 + B8 + B11} \quad (1)$$

It uses the spectral reflectance pattern of three land cover types: vegetation, water, and built-up areas. The FIEI will minimize the ratio of the spectral components of bands 3 (green), 8 (NIR), and 11 (MIR). The results of the FIEI approach were evaluated using the Modified Normalized Difference Water Index (MNDWI; Xu 2006).

3.4 The Modified Normalized Difference Water Index

Development of the MNDWI for flood mapping was motivated by research showing that the reflection of NIR waves is suitable for detecting water (e.g., Niwas et al. 2015; Ettehadi Osgouei et al. 2019). Meanwhile, the MNDWI uses green (band 3) and MIR (band 12) to enhance open water features. In MNDWI, the MIR band is used instead of the NIR band. This approach can distinguish between open land and built-up area features frequently correlated with open water.

The MNDWI can be calculated as:

$$MNDWI = \frac{B3 - B12}{B3 + B12} \quad (2)$$

This yields the following results:

1. At MNDWI, water has a positive value because water can absorb more MIR light than NIR;
2. The built-up area has a negative value; and
3. Soil and vegetation have negative values because soil reflects more MIR light than NIR light, and vegetation reflects more MIR light than green light (Xu 2006; Sathianarayanan 2018).

Several studies using the MNDWI approach have shown high accuracy for mapping flooded areas, with an overall accuracy value of 98% to 99% and kappa coefficients of 0.8 to 0.9 (Fisher et al. 2016; Zhou et al. 2017; Sivanpillai et al. 2021).

3.5 Threshold value treatment

According to Feyisa et al. (2014), the pixel TV for extraction of water bodies or flooding varies according to the location and time of image acquisition. In setting the TV of the FIEI, it is necessary to examine the pixel value in detail to ensure greater accuracy of the final result of flood mapping. The TV treatment used in this study is described in Table 3.

Table 3: Threshold value treatment.

No.	Threshold value	Pixel value	Description
1	TV1	< 0	Not flooded
		≥ 0	Flooded
2	TV2	< 0.05	Not flooded
		≥ 0.05	Flooded
3	TV3	< 0.1	Not flooded
		≥ 0.1	Flooded

3.6 Accuracy measurement

The results of the flood mapping from the Sentinel-2 Level 1C satellite imagery using the FIEI and MNDWI were tested for accuracy. For this purpose, ground truth data acquired by field survey were used (328 sites). The flood model performance was evaluated using the following criteria:

$$\text{User accuracy} = \frac{X_{ij}}{X_{i+}} \times 100\% \tag{3}$$

$$\text{Producer accuracy} = \frac{X_{ij}}{X_{+j}} \times 100\% \tag{4}$$

$$\text{Overall accuracy} = \frac{1}{N}\sum_{i=1}^{r} X_{ii} \times 100\% \tag{5}$$

$$\kappa = \frac{N\sum_{i=1}^{r} X_{ii} - \sum_{i=1}^{r} X_{i+} + X_{+i}}{N^2 - \sum_{i=1}^{r} X_i + X_{+i}} \times 100\% \tag{6}$$

In equations (3) to (6), X_{ii} is the diagonal value of the confusion (error) matrix, and X_{ij} is used for flooded and non-flooded area classifications. The matrix size $r = 2$, X_{i+} is the number of pixels in row i obtained from the remotely sensed analysis, X_{+j} is the number of column j obtained from referenced flood data, and N is the total number of pixels in the sample.

Table 4: Categorization based on a range of kappa coefficient (κ; Watson and Petrie 2010; Sivanpillai et al. 2021).

No.	Coefficient range	Classification
1	$\kappa < 0.00$	Very poor
2	$0 \leq \kappa \leq 0.20$	Poor
3	$0.21 \leq \kappa \leq 0.40$	Fair
4	$0.41 \leq \kappa \leq 0.60$	Moderate
5	$0.61 \leq \kappa \leq 0.80$	Good
6	$\kappa \geq 0.80$	Very good

The kappa coefficient (κ) measures how the classification results compare to values assigned by chance. Furthermore, it is computed from the error matrix and incorporates diagonal and off-diagonal elements (Sivanpillai et al. 2021). Based on the 2015 Indonesian National Institute of Aeronautics and Space guidelines on satellite data processing, the minimum level of accuracy required is 75%. Table 4 shows the range of kappa coefficients and the respective classification.

4 Results

4.1 Flooding extraction

The extraction of flooding for five villages with two approaches (FIEI and MNDWI) and three TVs resulted in thirty images. As an example, in Figure 3, the left column indicates that the MNDWI approach with TV1 treatment overestimated the flooded area. This can be observed especially in several residential or built-up areas.

4.2 Effect of threshold setting

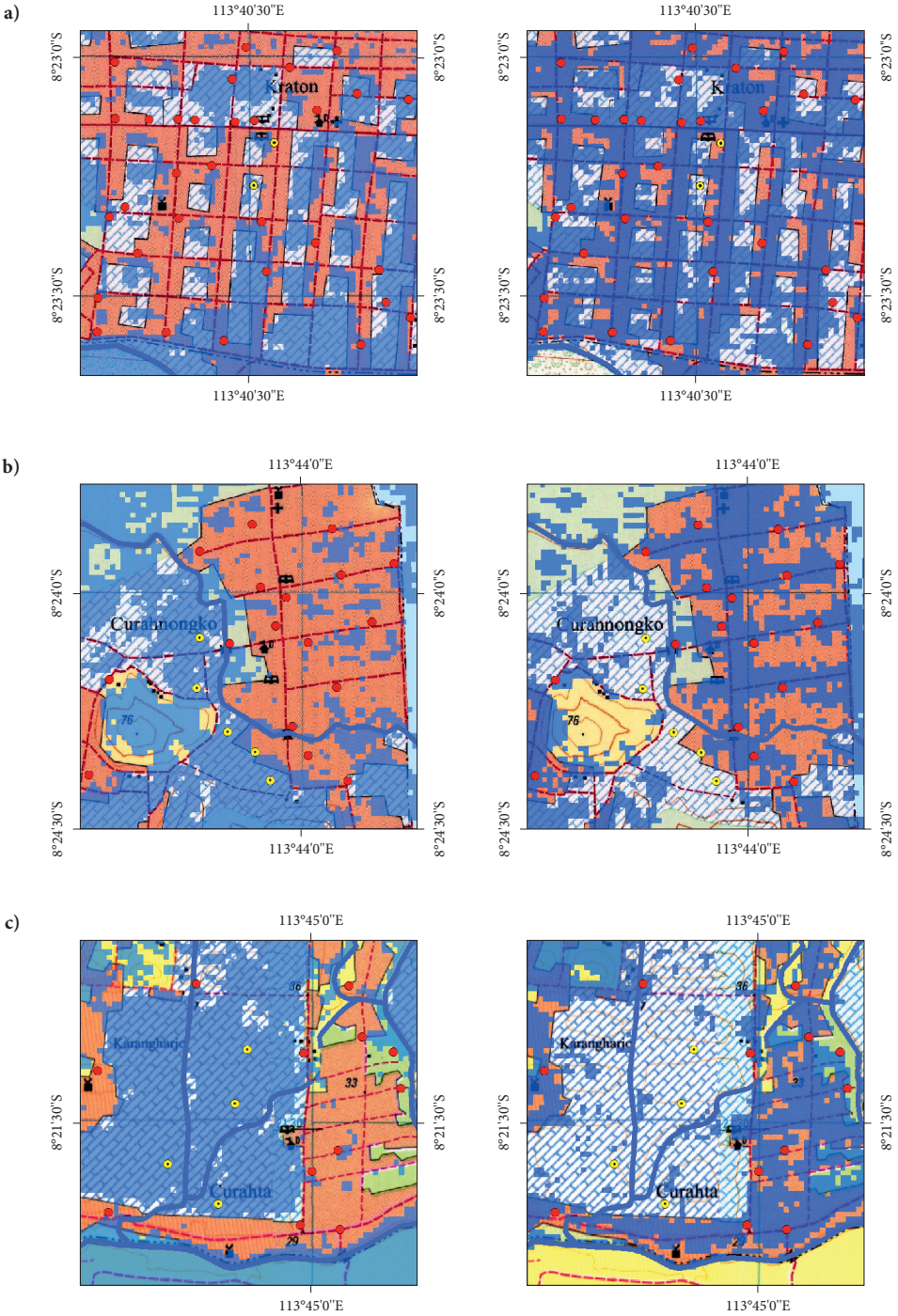
Applying TV treatment is critical to define the flooded and non-flooded areas accurately. Therefore, the application of several TVs to reduce pixel error in flooding extraction is necessary. Figure 4 shows the resulting flood mapping image based on FIEI, where the spatial extent of floods is reduced from TV1 to TV3 when the TV value is raised.

4.3 Accuracy measurement

The measurement results using the overall accuracy method and the kappa coefficients show that the FIEI approach is more accurate than the MNDWI in classifying and mapping flooded and non-flooded areas, as indicated in Table 5. The overall accuracy (OA) of the FIEI approach using three different TVs showed results above 70%, whereby Sanenrejo achieved the highest based on TV1 at 98.04%. Subsequently, the MNDWI approach showed overall accuracy results above 50%, with the TV1 treatment yielding the highest value of 79.69% for Curahnongko.

Table 5: Accuracy assessment for flood maps from the MNDWI and FIEI.

No.	Study area	Threshold value	Overall accuracy (%)		Kappa coefficients	
			FIEI	MNDWI	FIEI	MNDWI
1	Wonoasri	TV1	90.36	75.90	0.83	0.03
		TV2	83.13	64.44	0.54	0.01
		TV3	77.11	70.00	0.43	0.01
2	Curahnongko	TV1	95.24	79.69	0.8	0.17
		TV2	73.44	77.78	0.31	0.10
		TV3	75.81	79.37	0.38	0.12
3	Curahtakir	TV1	94.92	66.10	0.88	0.12
		TV2	77.97	64.41	0.54	0.26
		TV3	74.58	76.27	0.50	0.46
4	Sanenrejo	TV1	98.04	76.47	0.96	0.43
		TV2	90.20	54.90	0.79	0.05
		TV3	80.39	52.83	0.61	0.13
5	Sidodadi	TV1	95.83	79.17	0.86	0.10
		TV2	83.33	62.50	0.57	0.01
		TV3	75.00	58.33	0.44	0.06
Average of TV1			94.88	75.47	0.63	0.14


a)
113°40'30"E
8°23'0"S
8°23'30"S
Kraton
b)
113°44'0"E
8°24'0"S
8°24'30"S
Curahnongko
76
c)
113°45'0"E
8°21'30"S
Karanghario
Curahta
33
29

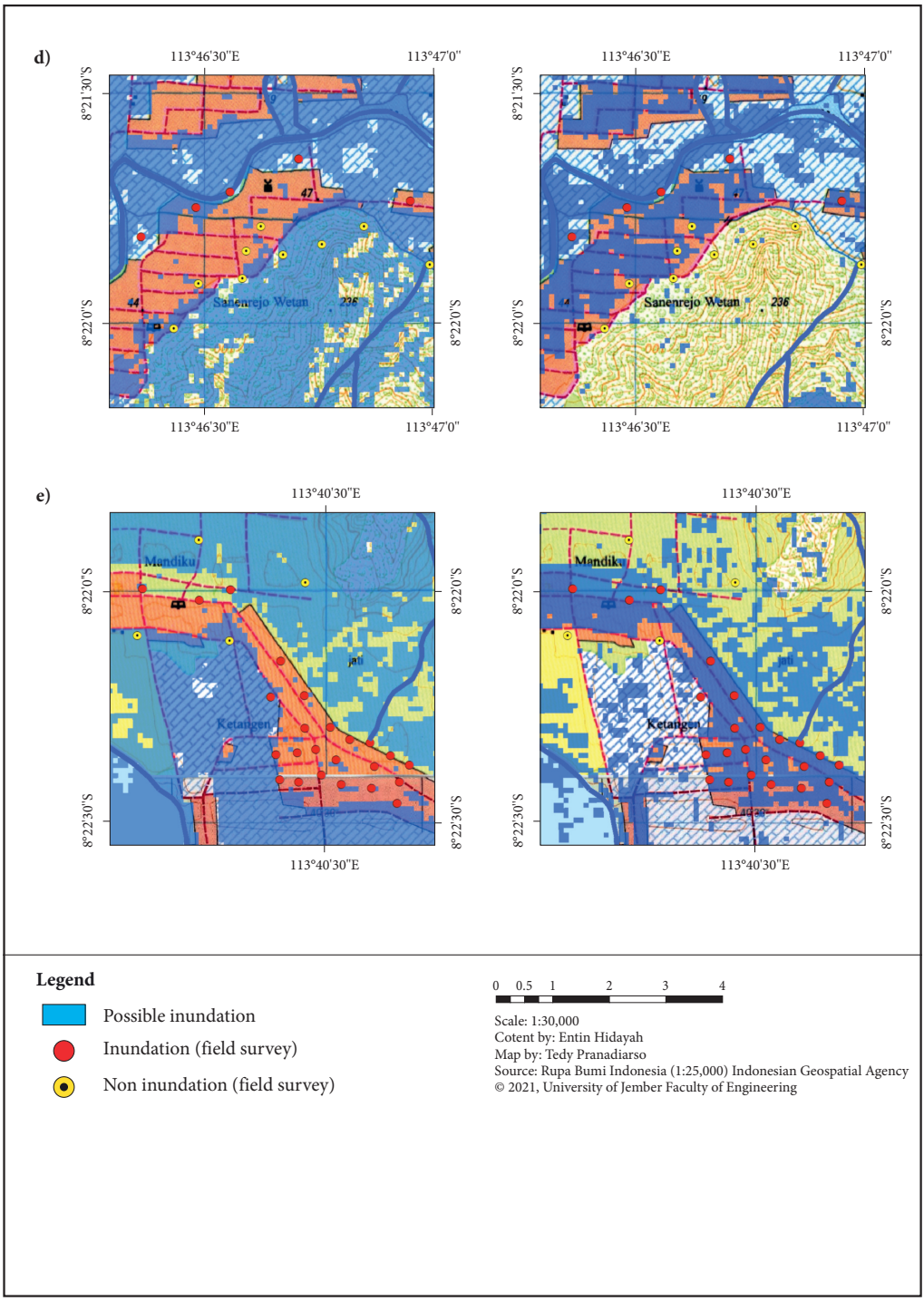


Figure 3: Flooding extraction using MNDWI (left) and FIEI (right) with TV1 for (a) Wonoasri, (b) Curahnongko, (c) Curahtakir, (d) Sanenrejo, and (e) Sidodadi. (p. 56–57)

The kappa coefficients show that the FIEI approach results are more accurate than the MNDWI results. The coefficients of the FIEI approach achieve over 0.8 for the case of TV1 treatment. The highest kappa coefficient of 0.96 is obtained using the FIEI approach in Sanenrejo. Meanwhile, the highest coefficients when using the MNDWI approach are seen in Curahtakir with TV3 treatment. The value of 0.46 obtained

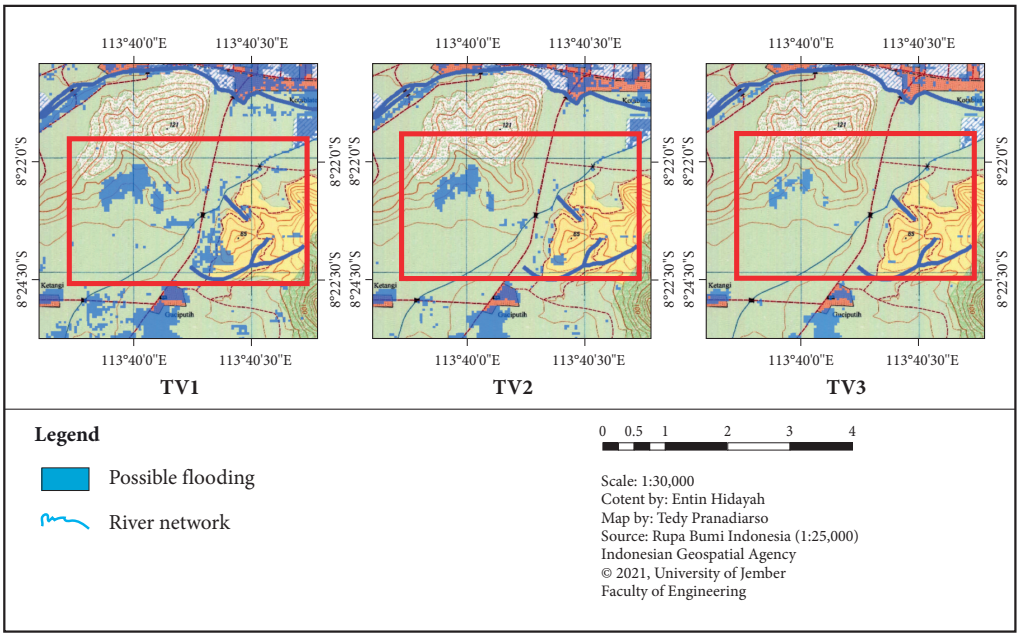


Figure 4: Effect of TV treatment for FIEI.

Table 6: User and producer accuracy assessment for the MNDWI and FIEI approaches.

No.	Study area	Threshold value	User accuracy (%)		Producer accuracy (%)	
			FIEI	MNDWI	FIEI	MNDWI
1	Wonoasri	TV1	91.43	87.14	98.46	84.72
		TV2	81.43	70.13	98.28	85.71
		TV3	74.29	77.92	98.11	85.71
2	Curahnongko	TV1	94.64	87.50	100.00	90.74
		TV2	73.21	83.93	97.62	90.38
		TV3	72.73	85.71	100.00	90.57
3	Curahtakir	TV1	95.12	82.93	97.50	72.34
		TV2	73.17	63.41	93.75	81.25
		TV3	65.85	80.49	96.43	84.62
4	Sanenrejo	TV1	100.00	93.94	97.06	75.61
		TV2	87.88	60.61	96.67	66.67
		TV3	72.73	39.39	96.00	72.22
5	Sidodadi	TV1	95.00	91.67	100.00	84.62
		TV2	80.00	68.33	100.00	83.67
		TV3	70.00	60.00	75.00	85.71

is considered a moderate accuracy. The lower accuracy results obtained by the MNDWI approach are due to the overestimation of flooded areas and misclassifications of flooded and non-flooded regions in residential areas or built-up land use.

The FIEI approach with TV1 treatment can more accurately map flooding in residential (or built-up areas) and vegetation areas than the MNDWI approach. It can produce flooding extraction closer to the actual flood occurrence without overestimation. This is validated by comparing the extracted flooded area with data from a field survey. In some evacuation locations, non-flooded areas are accurately spotted, facilitating evacuation efforts.

For the accuracy of flood maps used by natural disaster emergency response agencies, more detailed validations were needed to evaluate user accuracy (UA) and producer accuracy (PA).

Table 6 shows that the UA and PA values of the FIEI approach were higher than the MNDWI approach. Using the FIEI approach, the UA and PA values were above 90%, reaching 100%. This shows that the classification between flooded and non-flooded areas has been mapped accurately and reliably.

5 Discussion

In East Java Province, from 2017 to 2021, the average flood incidence is 115 events per year. According to the National Disaster Management Agency's data for 2022 showed that 111 people died, two were missing, 10,384 were evacuated, and 1,599 buildings were damaged (https://gis.bnpb.go.id/). Flood mapping is very expensive and takes a long time, hence the flood mapping technique with the Sentinel-2 image approach is needed for mitigation efforts (Sivanpillai et al. 2021).

Previously, the NDWI and MNDWI algorithms were applied based on Landsat, Sentinel-1, and Sentinel-2 images for rapid flood mapping with various features for water bodies and flooded areas. In Shouguang, both algorithms based on Sentinel-1 and Sentinel-2 with random forest classification for rivers showed OA values of 85.22% and 95.45%, respectively (Huang and Jin 2020). Furthermore, for rural watershed areas in Australia, using two algorithms based on Landsat Oli 8 imagery with unsupervised classification proved to be effective, with OA values of 96.04% and 95.70%, respectively (Ghofrani et al. 2019). Implementation on rivers and lakes in Canada, the Tennessee River in the US, the Swedish lake Lungsjön, and Mongolia's Lake Khar-Us using Sentinel-2 imagery showed outstanding accuracy with consecutive OA values based on the NDWI (0.97, 0.965, 0.94, and 0.925) and the MNDWI (0.97, 0.962, 0.96, and 0.945; Niu et al. 2022). The application of the Landsat image–based MNDWI to features of urban land, rural land, vacant land, swamps, and agricultural areas in the US had an overall accuracy of 93.92% (Sivanpillai et al. 2021). In addition, the MNDWI algorithm application based on the Landsat image for the same feature also yielded excellent results, as shown in Table 7 (Feyisa et al. 2014). The application of the MNDWI for coastal forests, agriculture, grasslands, shrubs, and forests in eastern Australia using Landsat imagery also resulted in outstanding accuracy, with an OA value of 97.95% (Fisher et al. 2016). Implementation of the NDWI and

Table 7: Implementation of MNDWI in several countries.

Location	Accuracy (%)	TV	Land use	Reference	Data sources
Denmark	98.05 (UA)	0.1	Reservoirs, a harbor, and the sea (Øresund and Køge Bay)	Feyisa et al. 2014	Landsat
Switzerland	99.84 (UA)	−0.15	Lake Lauerz, Lake Ägeri, Lake Sihl, Lake Wägital, Lake Klöntal	Feyisa et al. 2014	Landsat
Ethiopia	96.60 (UA)	0.1	Gefersa, Dire, Legedadi	Feyisa et al. 2014	Landsat
South Africa	94.46 (UA)	0.6	Berg River, Wemmershoek, Brandvlei	Feyisa et al. 2014	Landsat
New Zealand	98.14 (UA)	0.2	Lake Te Anau	Feyisa et al. 2014	Landsat
Eastern Australia	97.95 (OA)	0.1	Coastal forest, agricultural, grasslands, shrublands, woodlands	Fisher et al. 2016	Landsat
US	93.92 (OA)	0.2	Urban, rural, bare ground, marshes, agricultural area	Sivanpillai et al. 2021	Landsat
China	85.22 (OA)	0.35	Several rivers	Huang and Jin 2020	Sentinel-2
Spain	68 (OA)	−0.35	Wetlands	Pena-Regueiro et al. 2020	Sentinel-2

Note: UA = user accuracy, OA = overall accuracy.

MNDWI for rivers and lakes yielded excellent results. However, its implementation based on Sentinel-2 for coastal areas in Valencia in eastern Spain resulted a decrease in performance, as indicated by OA values of 89% and 68% (Pena-Regueiro et al. 2020). Similarly, in our research the application of the MNDWI for lowland flooding is also unsatisfactory, with an average OA value of 75.47% (Table 6). It is important to emphasize that the MNDWI has weaknesses in detecting the water layer underlying the built-up area in lowlands and also in the coastal area.

Therefore, with outstanding results, we are using the FIEI algorithm to develop rapid flood mapping using Sentinel-2 imagery and changing the band combination in lowland flooding. The performance of the FIEI approach provides an average increase in the overall accuracy of 19.41% from the MNDWI in consistent flood mapping for five villages in the Tempurejo sub-district, Jember Regency, Indonesia. The increased average of overall accuracy (19.41%) is obtained by calculating the mean of the overall accuracy of FIEI's TV1 minus the mean of the overall accuracy of MNDWI's TV1. As a highlight, the FIEI is an improvement from the MNDWI for lowland flooding by utilizing NIR waves sensitive to water that can capture lowland flooding. Meanwhile, the MNDWI application with the most optimal TV equaling 0 cannot provide better accuracy.

In addition to the combination of bands, the TV is also influential in achieving the best accuracy. Each country had a different TV for achieving the best accuracy, as shown in Table 7. Some locations had the same TV, equal to 0.1, such as Denmark, Ethiopia, and eastern Australia (Feyisa et al. 2014; Fisher et al. 2016). In addition, New Zealand and the US have the same TV score, at 0.2. In other countries, the best accuracy was obtained from a TV less than 0 (Feyisa et al. 2014; Sivanpillai et al. 2021; Xu 2006; Pena-Regueiro et al. 2020). Whereas this study shows that using an appropriate TV1 greater than or equal to 0 is flooding, the flooding extraction eliminates falsely classified pixels. In our study case, selecting the proper TV is expected to produce more optimal map accuracy.

The FIEI approach with treatment TV1 can effectively provide crucial and timely information on flooded areas to map out priority evacuation areas affected by disasters. This saves time in allocating resources to places that require evacuation to facilitate the distribution of logistical assistance. In line with Kaplan and Avdan's (2017) opinion, remote sensing techniques are often less costly and time-consuming for large geographic areas than conventional field mapping. The FIEI algorithm using Sentinel-2 imagery can be applied for rapid mapping of floods in other countries. This map is classified into flooded and non-flooded areas suitable for lowland applications and beneficial in planning flood mitigation. This flood map is certainly very useful in mapping flood risk (Ryu et al. 2017), planning flood mitigation (Sipelgas et al. 2021), or managing small retention ponds (Ferk et al. 2020).

6 Conclusion

The FIEI approach addressed the MNDWI's limitations and prevented overestimation of the flooded area. Compared to the MNDWI approach, it analyzes bands 3, 8, and 11 of Sentinel-2 to extract flooded areas more effectively. Furthermore, it provides higher accuracy with the appropriate TV treatment. The approach is recommended for quickly mapping flooded areas (if ground truth data are available) in the Tempurejo sub-district and similar lowland areas susceptible to flooding.

With free spatial data and ground truth data, the FIEI approach is suitable for deployment during disasters to provide quick flood mapping for response, evacuation, and mitigation efforts. The technique can be easily extended to other locations if the TV is successfully identified. For applying flood mapping outside Indonesia, such as in Denmark, Australia, China, New Zealand, and the US, a combination of bands 3 and 12 is recommended.

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INTEGRATED METHOD FOR GLOBAL LAND COVER PRODUCTS' VALIDATION ON THE EXAMPLE OF BULGARIA

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Integrated method for global land cover products' validation on the example of Bulgaria

ABSTRACT: The article presents the validation of four global land cover datasets for 2009–2010 (GlobeLand30, GlobCover, Forest/Non-forest map, Tree canopy cover) for the territory of Bulgaria as a part of a task led by the Group on Earth Observation (GEO). An integrated method for validation, combining the GIS processing capabilities, various data and the expert knowledge-based method of visual interpretation was developed. It aims to be an effective, time-saving approach, allowing validation of several datasets in one environment. The results are presented in vector format with structured attribute data for all validated datasets. The analysis reveals that the highest accuracy is observed for Tree canopy cover (96.1%), the lowest for GlobCover 2009 (51.0%), and the other products' accuracy is considerably high, about 80.0%.

KEY WORDS: land cover validation, global land cover products, integrated method, GIS processing, visual interpretation, Bulgaria

Integrirana metoda za validacijo globalnih produktov pokrovnosti tal na primeru Bolgarije

POVZETEK: V članku je predstavljena validacija štirih globalnih podatkovnih nizov pokrovnosti tal za obdobje 2009–2010 (GlobeLand30, GlobCover, Forest/Non-forest map, Tree canopy cover) za ozemlje Bolgarije v okviru naloge, ki jo je vodila organizacija GEO. Razvita je bila integrirana metoda za validiranje, ki združuje zmogljivosti obdelave GIS, različne podatke in metodo vizualne interpretacije, temelječe na ekspertnem znanju. Gre za učinkovit in časovno varčen pristop, ki omogoča potrjevanje več podatkovnih nizov v enem okolju. Rezultati so predstavljeni v vektorski obliki s strukturiranimi atributnimi podatki za vse potrjene podatkovne nize. Analiza je pokazala, da je največja natančnost ugotovljena za Tree canopy cover (96,7 %), najmanjša pa za GlobCover 2009 (51,0 %). Natančnost ostalih podatkovnih slojev je precej visoka, približno 80 %.

KLJUČNE BESEDE: validacija pokrovnosti tal, globalni produkti pokrovnosti tal, integrirana metoda, GIS obdelava, vizualna interpretacija, Bolgarija

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1 Introduction

Land cover is defined as the observed (bio-)physical cover of the Earth's surface (Di Gregorio and Jansen 1998). It includes various types of vegetation cover, man-made objects, bare land and inland water surfaces. Global, continental and regional land cover products serve as essential source of information for various applications, services, and global natural and anthropogenic processes and phenomenon as global climate changes, global land cover changes, deforestation, soil degradation, anthropogenization; policies and policy making at global, regional and national level as sustainable development, climate change monitoring, security, food and water security, land management, conservation, etc. (European Commission and Eurostat 1999; Grekousis, Mountrakis and Kavouras 2015; Tsendbazar, de Bruin and Herold 2015; Herold et al. 2016; Chen et al. 2016a; 2017).

During the past decades, several global land cover products with spatial resolution varying from 1 km to 25 m were produced using different remote sensing data – 1 km and 500 m global land cover (GLC) products from AVHRR and MODIS data (Hansen et al. 2000; Loveland et al. 2000; Grekousis, Mountrakis and Kavouras 2015), European Space Agency (ESA) global land cover product GlobCover with 300 m resolution (Bontemps et al. 2011) and products with finer resolutions such as GlobeLand30 product of National Geomatics Center of China (NGCC) with 30 m (Chen, Yifang and Songnian 2014; Ran and Li 2015), the datasets developed within the Global Forest Watch and Global Forest Monitoring projects – 30 m (Hansen et al. 2013), and a Forest/Non-forest dataset with 25 m resolution of Japan Aerospace Exploration Agency (JAXA) (Shimada et al. 2014).

The validation process is a suite of techniques, which are used for determining the quality of a certain product (Strahler et al. 2006). According to the definition of the Committee on Earth Observing Satellites Working Group on Calibration and Validation the term validation is defined as »The process of assessing, by independent means, the quality of the data products derived from the system outputs« (Achard et al. 2011, 13). The overall structure of the validation process typically includes several stages.

The statistically based or quantitative method of validation requires selection of the sampling design and allocation, selection of reference data and visual interpretation, and accuracy assessment and interpretation of the results from the validation of the land cover products (Strahler et al. 2006). The sampling method refers to the rules used for allocation of sample units (points or polygons) within the area which will be validated. The stratification, commonly part of the sampling design, allows to specify the samples allocated to each stratum, where the strata are the land cover classes (Olofsson et al. 2012). Many different sampling methods exist, such as simple random sampling, stratified random sampling, cluster sampling, etc. and there is no universal sampling design suitable for all global validations and assessments (Strahler et al. 2006). To improve the spatial sampling design and allocation, a landscape shape index-based approach was developed and implemented in the online validation tool for GlobeLand30 product: GeoVal – GLC Validation Platform (Chen et al. 2016b). It takes into consideration the spatial heterogeneity of the land cover in estimation of the sample size and their spatial distribution.

The sample units for a validation of a certain territory are visually interpreted using interpretation keys and various reference data and sources (Mayaux et al. 2006; Achard et al. 2011; Olofsson et al. 2012; Congedo and Munafò 2012). The prior information and knowledge for the geographical region which is validated is also important. The knowledge-based verification uses information about the natural environment and human activities which affect the distribution of the land cover and defines rules, taking into consideration three types of knowledge – natural, cultural and temporal (Chen et al. 2015; Zhang et al. 2016).

Accuracy assessment refers to the process which determines the quality of a product or map, created from remote sensing data after the validation is made (Congedo and Munafò 2012). There are many statistical methods and parameters applied for assessment of the classification accuracy and its representation, including, error matrix, overall accuracy, user's and producer's accuracy, Kappa statistics, spatial accuracy, etc. (Mayaux et al. 2006; Strahler et al. 2006; Achard et al. 2011; Congedo and Munafò 2012; Brovelli et al. 2015; Tsendbazar et al. 2015).

The current study aims to presents an integrated method for validation of global land cover products, developed and applied to the validation of four global land cover datasets for the territory of Bulgaria. It is focused on the application of GIS processing and visual interpretation, and proposing a validation and decision-making approach which allows validation of several datasets in one environment and generating as a final result a single file with the validation information for all GLC products.

The GLC validation for the territory of Bulgaria has been carried out within the international task Data Validation of Global Land Cover Datasets with 30 m resolution, which is part of the Group on Earth Observation (GEO) component SB-02-C2 Global Land Cover Validation and User Engagement (https://www.earthobservations.org). The global land cover datasets which have been validated within the GEO-led international task were GlobeLand30 dataset in 30 m resolution from NGCC, GlobCover dataset in 300 m resolution from ESA, Europe, Forest/Non-Forest Map dataset in 25 m resolution from Japan, and Global Forest Watch dataset in 30 m resolution from Maryland University, USA. The global land cover products selected for validation are for one and the same time period – 2009/2010, providing valuable and credible information for the land cover of a given moment in time and being very useful for studying processes in time.

2 Methods and Data

2.1 Study area

The validation was conducted for the territory of Bulgaria. Bulgaria is a Southeastern European country, located at the Balkan Peninsula and covering an area of 110,994 km² (Figure 1). It is characterized by significant diversity, heterogeneous landscapes and a variety of landforms. It lies at the southern parts of the temperate climatic zone at the transition to the Mediterranean climate in the southern part which determines the transitivity of characteristics of the natural components (Penin 2000). The SRTM digital terrain model for Bulgaria (Figure 1) gives an overall impression for the diversity of landforms and the segmentation of the relief. The plains and lowlands, situated in the northern part of the country are part of Danubian plain, where the steppe character of the vegetation can be observed. Significant part of the territory of Bulgaria is occupied by mountains: the Stara planina mountain chain and Sredna Gora Mountains, crossing the country in the middle from west to east, the Rila–Rhodope Mountain areas in the southwest and south part of Bulgaria. Bulgaria is also one of the richest in biodiversity European countries and 34.9% of its territory falls into the European ecological network Natura 2000 according to information published at Ministry of Environment and Water of the Republic of Bulgaria website (https://www.moew.government.bg/en/nature/).

Due to the specifics of the natural component the land cover of Bulgaria is strongly heterogeneous. In Bulgaria, as well as in whole Europe the land cover is rather segmented and the main land cover types which could be observed are typical for European territory – urban areas, agricultural areas, forests (coniferous, deciduous and mixed), which covers 38% of the territory of Bulgaria, bare lands, water areas and wetlands, etc. (Figure 1).

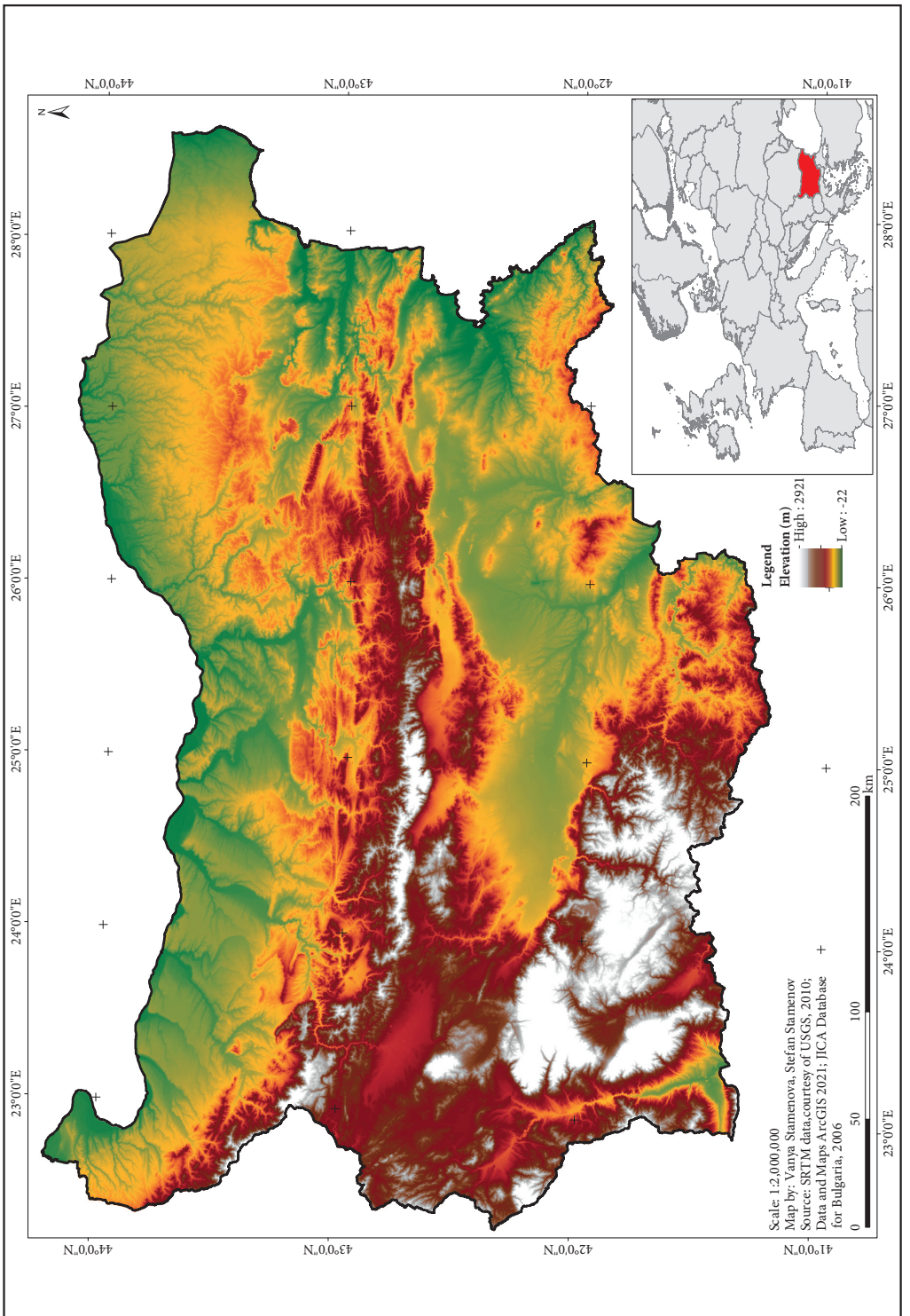
2.2 Global land cover datasets

Four GLC datasets for the period 2009–2010 have been validated for the territory of Bulgaria: GlobeLand30 dataset for 2010 (30 m), GlobCover 2009 dataset (300 m), Forest/Non-Forest Map for 2010 (25 m) and tree canopy cover dataset for 2010 (30 m) (Table 1).

Table 1: Used global land cover datasets.

Name of the dataset	Source	Year of production	Website
GlobeLand30	NGCC	2010	http://www.globallandcover.com
GlobCover	ESA, Europe	2009	http://due.esrin.esa.int/page_projects.php
Forest/Non-Forest Map	JAXA, Japan	2010	http://www.eorc.jaxa.jp/ALOS
Tree canopy cover	Maryland University, USA	2010	http://glad.umd.edu/dataset

Figure 1: Location and general view of Bulgaria. ➤ p. 67


N
Legend
Elevation (m)
High : 2921
Low : -22
Scale: 1:2,000,000
Map by: Vanya Stamenova, Stefan Stamenov
Source: SRTM data,courtesy of USGS, 2010;
Data and Maps ArcGIS 2021; JICA Database
for Bulgaria, 2006
0 50 100 200
km
23°0'0"E
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26°0'0"E
27°0'0"E
28°0'0"E
44°0'0"N
43°0'0"N
42°0'0"N
41°0'0"N

GlobeLand30 product (30 m) is a NGCC's product derived by classification of multispectral Landsat TM and ETM+ images and multispectral images of the Chinese Environmental Disaster Alleviation Satellite (HJ-1) without clouds for 2010, ranging plus/minus 1 year (National Geomatics … 2014). It consists of 10 land cover classes: 10 – cultivated land, 20 – forest, 30 – grassland, 40 – shrubland, 50 – wetland, 60 – water bodies, 70 – tundra, 80 – artificial surfaces, 90 – bare land and 100 – permanent snow and ice.

The GlobCover project is an initiative of ESA, started in 2005 in partnership with JRC, EEA, FAO, UNEP, GOFC-GOLD and IGBP, aiming to develop a service capable of delivering global composites and land cover maps using as input observations from the 300 m resolution MERIS sensor on board the ENVISAT satellite mission (Bontemps et al. 2011). The GlobCover 2009 land cover product is derived from a global MERIS FR mosaic for the year 2009. This is the second product generated within the GlobCover project, after its first release in 2005, which has spatial resolution of 300 m and its map projection is a Plate-Carrée (WGS84 ellipsoid). The land cover classification scheme of the GlobeCover2009 includes 22 land cover classes defined with the United Nations (UN) Land Cover Classification System (LCCS) (Di Gregorio and Jansen 1998; Bontemps et al. 2011).

The global forest/non-forest map is a free dataset generated by JAXA through classification of the backscattering intensity values of the global PALSAR-2/PALSAR mosaic dataset with 25 m resolution. The strong backscattering values in HV-polarization of the global PALSAR-2/PALSAR mosaic dataset are classified as »forest« (shown in green color), while the low backscatter as »non-forest« (colored in yellow) (Japan Aerospace … 2016). In the forest/non-forest dataset, the class »forest« is defined as the natural forest with the area larger than 0.5 ha and forest cover over 90%, corresponding to the Food and agriculture organizations of the United Nation's definition (FAO-FRA 2000; Food … 2012). The dataset includes three types of classes – forest, non-forest and water.

The tree canopy cover dataset for 2010 is a global product of tree canopy cover including all vegetation taller than 5 m in height, represented as a percentage per grid cell 30 × 30 meter in range from 0 to 100. Percent tree cover is defined as the density of tree canopy coverage of the land surface, and it estimates the percent maximum of the tree canopy for 2010 (the peak of the growing season) from cloud-free annual growing season composite Landsat 7 ETM+ data. A regression tree model estimating per pixel percent tree canopy cover was applied to annual composites from 2000 to 2012 inclusive (Hansen et al. 2013). The datasets were generated by GLAD (Global Land Analysis & Discovery) lab at the University of Maryland, US Geological Survey (USGS), NASA, and other partners of the Global Forest Watch Initiative and the data for Bulgaria were downloaded from the website of USGS (https://landcover.usgs.gov/glc/).

2.3 Reference layers and datasets

Different reference data have been used for the validation of the global land cover datasets – high resolution satellite images, aerial photos, and additional information about land cover of the territory of Bulgaria (Table 2). The reference layers and datasets must be synchronous in time with the data being validated.

The main source of information used for the validation are color orthophoto maps of Bulgaria, with spatial resolution 0.5 m and 0.4 m, acquired in 2006 and 2010–2011, respectively, provided by the Ministry of agriculture, food and forests of Republic of Bulgaria for scientific use. High resolution satellite imagery basemaps layers available in ArcGIS online platform and the Corine Land Cover data for 2012 have been used additionally for reference source of information.

Table 2: Used reference datasets.

Name of the dataset	Source	Year of production	Website
Orthophoto maps for Bulgaria	Ministry of agriculture, food and forests, Bulgaria	2010–2011	
Corine Land Cover	Copernicus Portal	2012	http://land.copernicus.eu
High resolution satellite imagery basemap layers	ArcGIS Online	–	https://www.arcgis.com/

2.4 Validation process

For the purpose of GLC products validation an integrated method was developed and applied, which gives the possibility for validation of several datasets in one environment and producing one file with the results, not several. The method was aimed to be as simple as possible, effective and time saving. The workflow process of the proposed integrated method consists of four main steps named – Preparation, Online Validation, Processing in GIS Environment and Validation, and Accuracy Assessment and Representation (Figure 2).

The first stage is the preparation, where the four GLC datasets which cover the study area have been downloaded and extracted by mask and the reference data were chosen and collected. The sampling procedure was chosen to fulfill two main requirements – to be suitable for areas with high landscape heterogeneity and the points to be evenly distributed over the whole territory of Bulgaria.

Initially the validation of GlobeLand30 product has been performed in its own online validation platform GeoVal where the sample points for the territory of Bulgaria has been generated. The sampling method used for the generation of the sample points is Landscape Shape Index (LSI), selection method of random

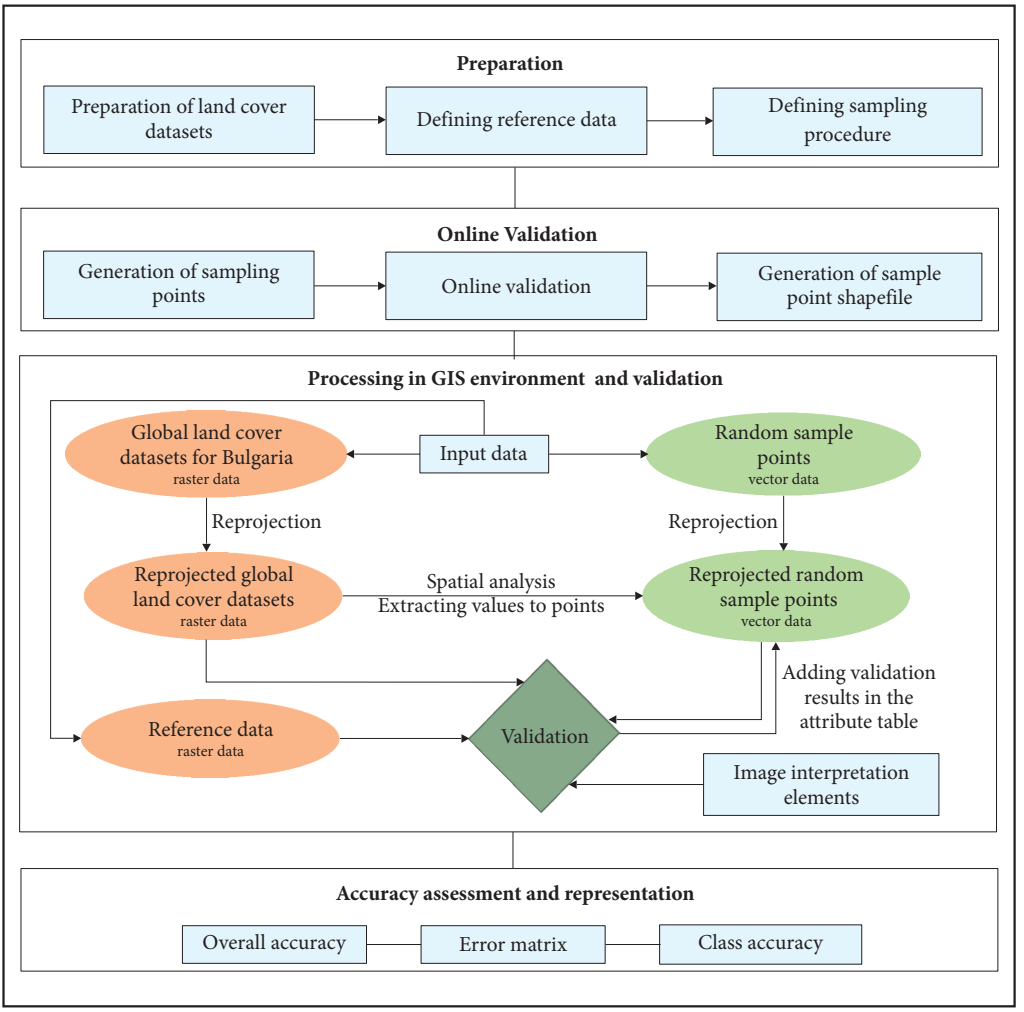


Figure 2: Overall structure of the validation process.

sampling at 95% confidence level, and plausibility judgment as sample judgment method. The LSI method is suitable for territories with spatial heterogeneity of the land cover, since it takes into consideration this heterogeneity and provides for better spatial sample allocation and distribution (Chen et al. 2021). The validation has been made using 382 randomly generated sample points for the whole territory of Bulgaria (Figure 3). The generation of the sample points has been made based on the Globeland30 land cover product and the same points have been used for the validation of the other three land cover dataset which provides for the comparability of results. The sample points were exported from the online validation platform and the validation has been continued in ArcGIS environment.

The next step of the GLC validation is the data processing in GIS environment and performing the validation using visual interpretation method. GIS allows all data to be stored, manipulated, processed and analyzed. All raster and vector data (GLC datasets, validation sample points and reference data) are reprojected in unified coordinate system, which in this case is UTM WGS 84, zone 35N. To the attribute table of the sample point shapefile new columns are added to store the validation results. The information about the land cover type values for each of the datasets have been extracted using the Spatial Analyst tools in ArcGIS – Extract Multi Values to Points and stored in the sample points shapefile attribute table lctype column. The process of validation is conducted after extraction through visual interpretation of the reference images and assigning the correct land cover values for each sample point. In the process of interpretation direct (shape, size, tone etc.) and indirect (association and location) interpretation elements are used (Akovetsky 1983; Lillesand and Kiefer 1999) and the results are stored in the shapefile table. The final product of the validation process is a shapefile with attributive table containing all the information for the land cover classes classified and ground truth, their index numbers and names. The designed structure of the sample point shapefile attribute table contains columns storing information for the land cover types for each land cover dataset. For each dataset three attribute columns have been generated with exception of Tree canopy cover dataset where the data are presented as a percentage value and are stored in two columns:

- column storing the index values for the land cover types,
- column with the names of the land cover types,
- column with the land cover codes assigned during the validation.

3 Results

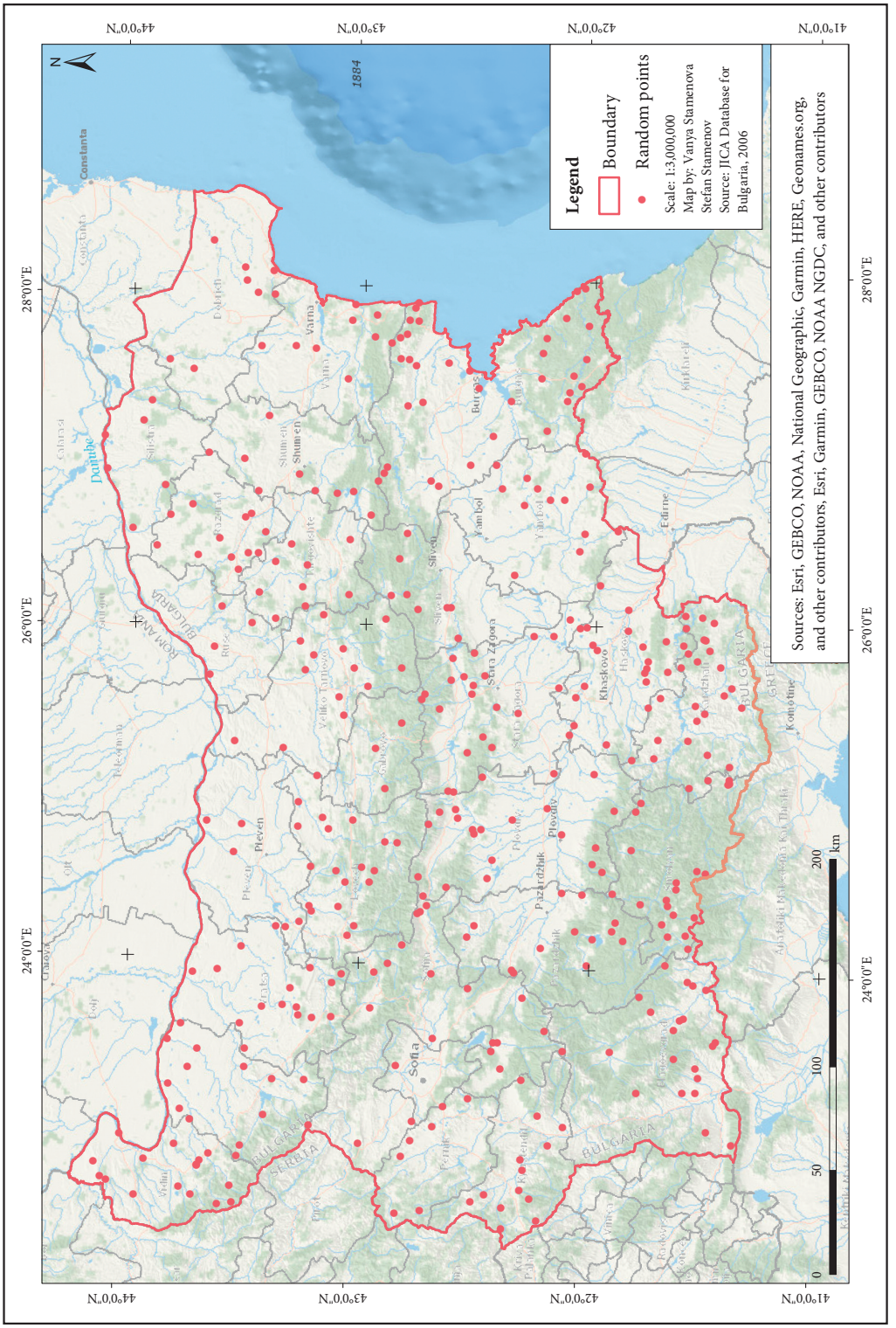
In this section the results obtained from the GLC products' validation and the estimated accuracies using the proposed integrated method are presented. For validating the products, a geodatabase for the territory of Bulgaria has been designed and built (Figure 4). The geodatabase has file structure and is built using ArcGIS 10.5 software. It contains raster global land cover datasets, reference datasets, vector layers and tables.

The final product generated as a result of the performed validation process is the creation of a vector layer, containing the whole information from the validation for each global product. Using the attribute data for each of the validated dataset error matrix tables have been generated.

3.1 Validation of GlobeLand30 dataset

The land cover map of Bulgaria, based on the GlobeLand30 dataset for 2010 (Figure 5), shows that the most prevalent land cover class is cultivated land, followed by the class forest. The GlobeLand30 dataset was validated first in the online validation platform GeoVal, where google maps were integrated, and then it was checked again together with the validation of the other three land cover datasets in GIS. The results of the validation are presented as error matrix in Table 3. The results of validation of the Globeland30 showed an overall accuracy of 79.8%. Table 3 provides information about the producer and user accuracy for each of the land cover classes. Highest producer accuracy (over 80.0%) is observed for the cultivated land, forest and water bodies and artificial areas classes, while shrubland and wetland land cover classes have lowest results. The land cover class with highest user accuracy is forest (92.2%), followed by the artificial areas, while lowest user accuracy is estimated for the wetland land cover class (Chen et al. 2021).

Figure 3: Distribution of the randomly selected sample points for the territory of Bulgaria. ► p. 71


Legend
Boundary
Random points
Scale: 1:3,000,000
Map by: Vanya Stamenova
Stefan Stamenov
Source: JICA Database for Bulgaria, 2006
Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors, Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
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Constanta
Varna
Shumen
Sliven
Yambol
Edirne
Pleven
Sofia
Plovdiv
Pazardzhik
Stara Zagora
Khaskovo
Kardzhali
Kotel
Burgas
Dobrich
Silistra
Ruse
Veliko Tarnovo
Gabrovo
Lovech
Montana
Vidin
Pernik
Kyustendil
Blagoevgrad
Smolyan
Targovishte
Razgrad
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BULGARIA
SERBIA
GREECE

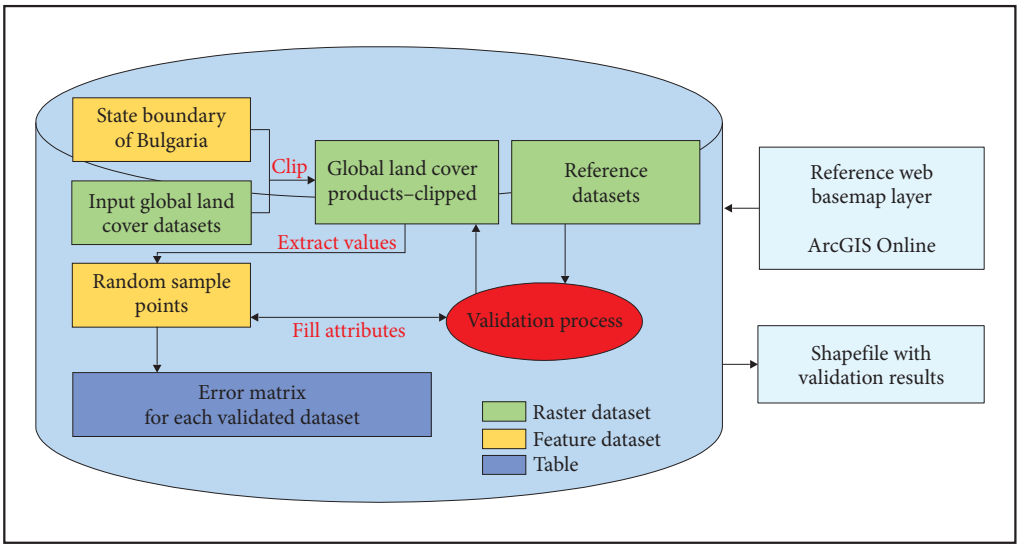


Figure 4: Geodatabase for GLC validation.

3.2 Validation of the GlobCover2009 product

The GlobCover2009 land cover dataset has 22 land cover classes, 17 are presented on the territory of Bulgaria (Figure 6). The result from validation is presented in Table 4, and the estimated overall accuracy is 51.04%. Many of the sample points fall within areas with mixed land cover, so during the interpretation the prevailing land cover type for each 300 m pixel was taken into consideration and the most appropriate land cover type was assigned.

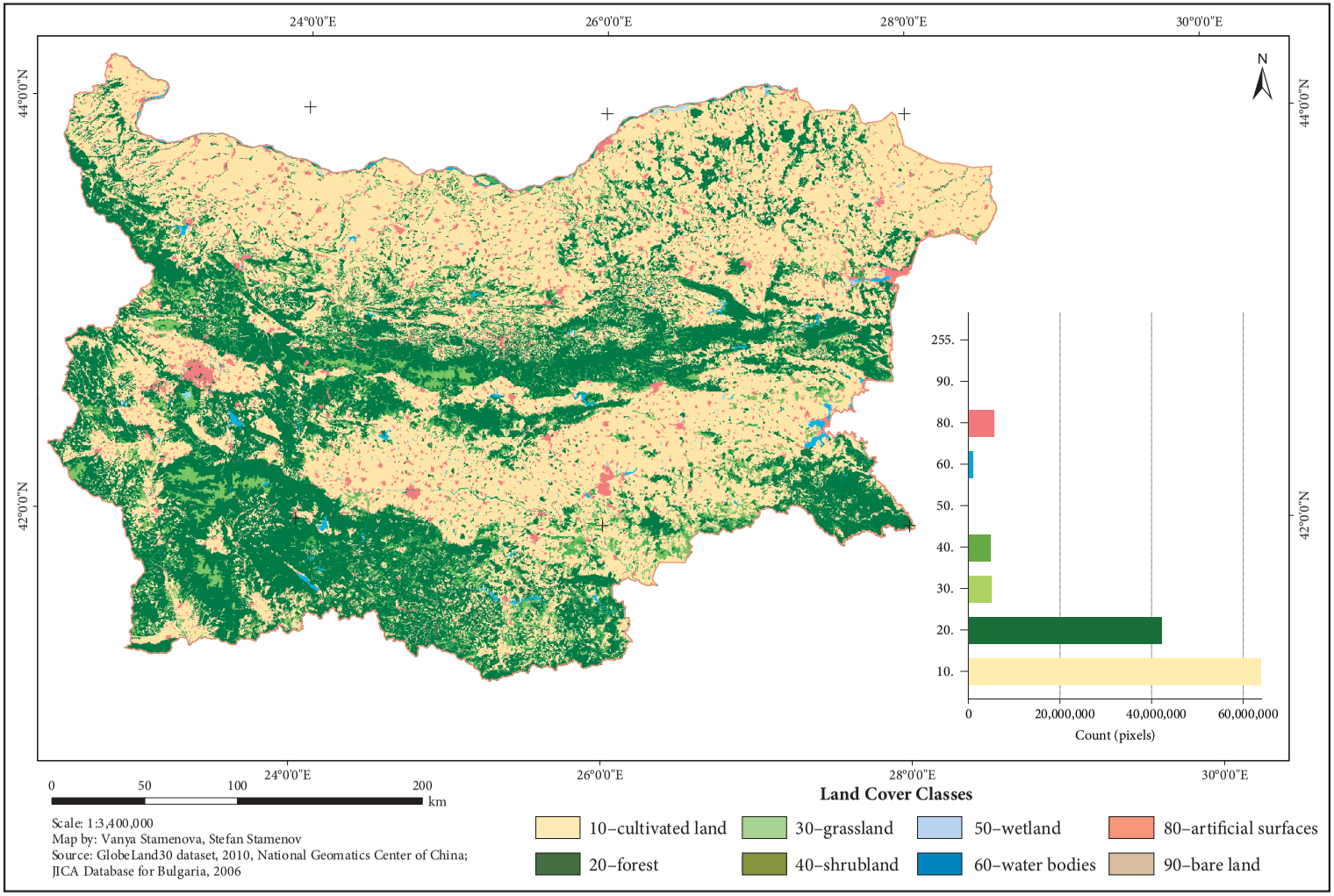
The land cover classes with user accuracy over 80% are unitary classes – class 70 and class 190, while the lowest user accuracy (0%) is received for the compound vegetation land cover classes – class 110, class 120, class 140 and the class 180 (Figure 6, Table 4). The producer accuracy shows similar results. Highest values are observed for three simple classes, which include only one type of land cover – needleleaved evergreen forest, shrubland and sparse (<15%) vegetation (e.g. land cover classes 70, 130, 150). Worst producer accuracy results (0%) have four classes, the same compound land cover classes with low user accuracy – classes 110, 120, 140 and 180. The lower overall accuracy obtained for the GlobCover 2009 dataset is due to the large number of mixed pixels.

3.3 Validation of Forest/Non-Forest dataset

The global forest/non-forest product of the JAXA has smallest pixel size of 25 m and contains three land cover classes – forest, non-forest and water areas. The map of the forest and non-forest areas for the territory of Bulgaria, based on the JAXA's global product for 2010 is shown on Figure 7. The results of the validation are presented as the error matrix in Table 5.

The estimated overall accuracy for this product is 80.1%. The calculated user accuracy is higher than the producer accuracy for all the classes. The lowest value of per class accuracy is observed for the producer accuracy of water class.

Figure 5: Land cover map of Bulgaria based on the GlobeLand30 product. ► p. 73
Figure 6: Land cover map of Bulgaria based on the GlobCover 2009 product. ► p. 74–75
Figure 7: Forest / Non-forest map of Bulgaria for 2010. ► p. 77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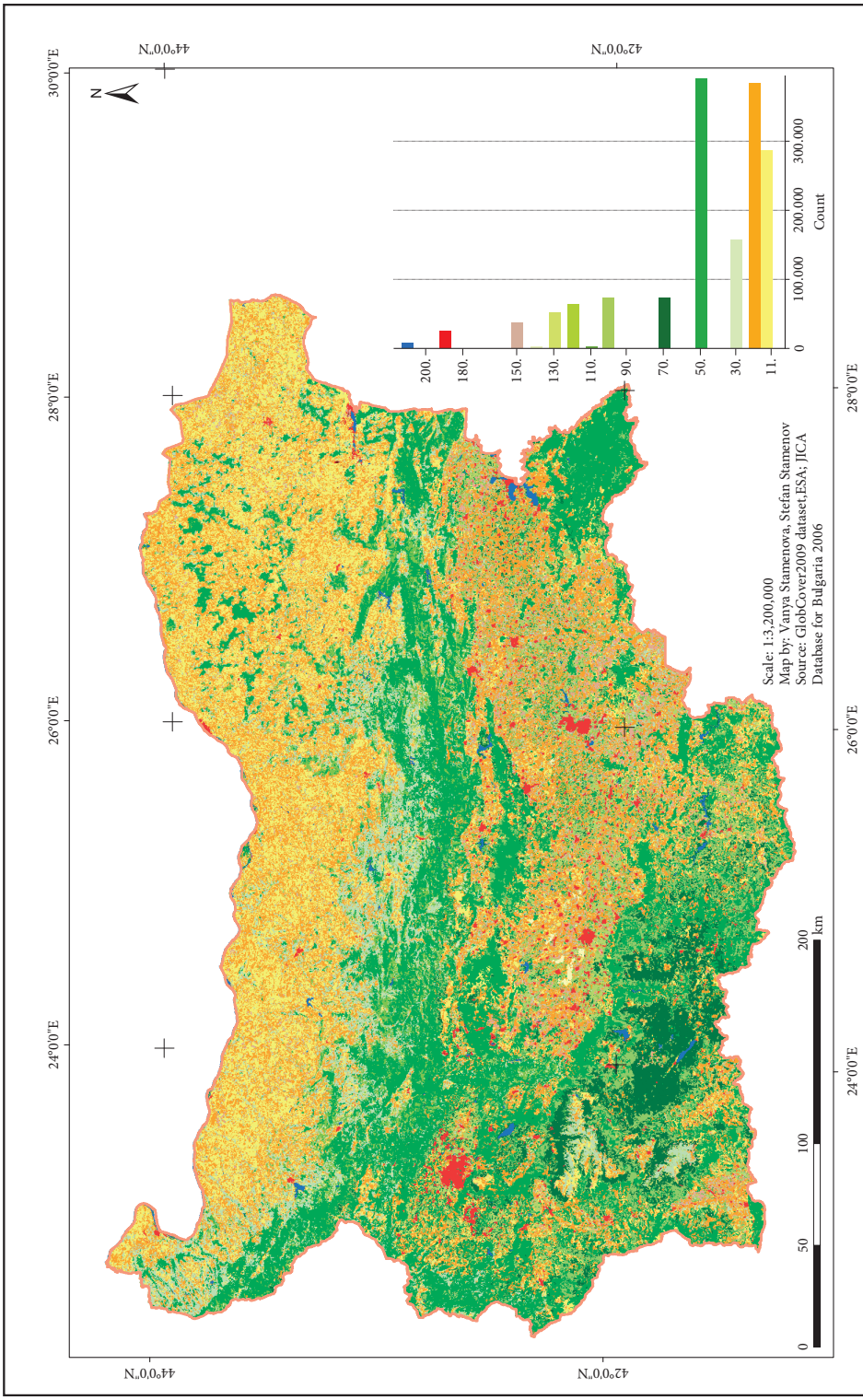
Land Cover Classes
10–cultivated land
20–forest
30–grassland
40–shrubland
50–wetland
60–water bodies
80–artificial surfaces
90–bare land
Scale: 1:3,400,000
Map by: Vanya Stamenova, Stefan Stamenov
Source: GlobeLand30 dataset, 2010, National Geomatics Center of China;
JICA Database for Bulgaria, 2006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Scale: 1:3,200,000
Map by: Vanya Stamenova, Stefan Stamenov
Source: GlobCover2009 dataset,ESA; JICA
Database for Bulgaria 2006
Count
0
100.000
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11.
30.
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70.
90.
110.
130.
150.
180.
200.


Land cover classes
11–Post–flooding or irrigated croplands (or aquatic)
14–Rainfed croplands
20–Mosaic cropland (50–70%) / vegetation (grassland/shrubland/forest) (20–50%)
30–Mosaic vegetation (grassland/shrubland/forest) (50-70%) / cropland (20–50%)
50–Closed (>40%) broadleaved deciduous forest (>5m)
70–Closed (>40%) needleleaved evergreen forest (>5m)
90–Open (15–40%) needleleaved deciduous or evergreen forest (>5m)
100–Closed to open (>15%) mixed broadleaved and needleleaved forest (>5m)
110–Mosaic forest or shrubland (50–70%) / grassland (20–50%)
120–Mosaic grassland (50–70%) / forest or shrubland (20–50%)
130–Closed to open (>15%) (broadleaved or needleleaved, evergreen or deciduous) shrubland (<5m)
140–Closed to open (>15%) herbaceous vegetation (grassland, savannas or lichens/mosses)
150–Sparse (<15%) vegetation
180–Closed to open (>15%) grassland or woody vegetation on regularly flooded or waterlogged soil–Fresh, brackish or saline water
190–Artificial surfaces and associated areas (Urban areas >50%)
200–Bare areas
210–Water bodies

Table 3: Error matrix for GlobeLand30 dataset (Chen et al. 2021).

Land cover (number of points)	10	20	30	40	50	60	70	80	90	100	All	User accuracy (%)
10	75	10	7	10	0	0	0	4	0	0	106	70.8
20	5	154	4	4	0	0	0	0	0	0	167	92.2
30	2	9	26	7	0	1	0	1	0	0	46	56.5
40	1	3	2	23	0	0	0	0	0	0	29	79.3
50	0	0	0	1	1	0	0	0	0	0	2	50.0
60	0	0	1	0	1	5	0	0	0	0	7	71.4
70	0	0	0	0	0	0	0	0	0	0	0	0.0
80	1	0	1	1	0	0	0	21	0	0	24	87.5
90	0	1	0	0	0	0	0	0	0	0	1	0.0
100	0	0	0	0	0	0	0	0	0	0	0	0.0
All	84	177	41	46	2	6	0	26	0	0	382	0.0
Producer accuracy (%)	89.3	87.0	63.4	50.0	50.0	83.3	0.0	80.8	0.0	0.0	0.0	79.8

Table 4: Error matrix for GlobCover2009 dataset.

Land cover (number of points)	14	20	30	50	70	100	110	120	130	140	150	180	190	210	Total	User Accuracy (%)
14	23	4	5	7	1	0	6	2	0	0	0	0	5	0	53	43.4
20	12	24	4	6	1	0	11	4	0	0	0	0	6	0	68	35.3
30	4	7	16	8	0	0	9	1	0	0	0	0	4	0	49	32.7
50	2	2	9	85	0	4	10	8	1	1	0	0	1	0	123	69.1
70	0	0	1	0	15	0	0	0	0	0	0	1	0	1	18	83.3
100	0	1	0	3	1	15	5	0	0	0	0	0	0	0	25	60.0
110	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0
120	0	3	1	8	0	0	5	0	0	0	0	0	0	0	17	0.0
130	0	0	1	1	0	0	1	1	5	0	0	0	0	1	10	50.0
140	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0.0
150	1	1	0	0	0	0	0	0	0	0	1	0	0	0	3	33.3
180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
190	0	1	1	0	0	0	0	0	0	0	0	0	8	0	10	80.0
210	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	100.0
Total	42	44	38	120	18	19	47	16	6	1	1	1	24	5	382	0.0
Producer Accuracy (%)	54.8	54.5	42.1	70.8	83.3	78.9	0.0	0.0	83.3	0.0	100.0	0.0	33.3	60.0	0.0	51.0

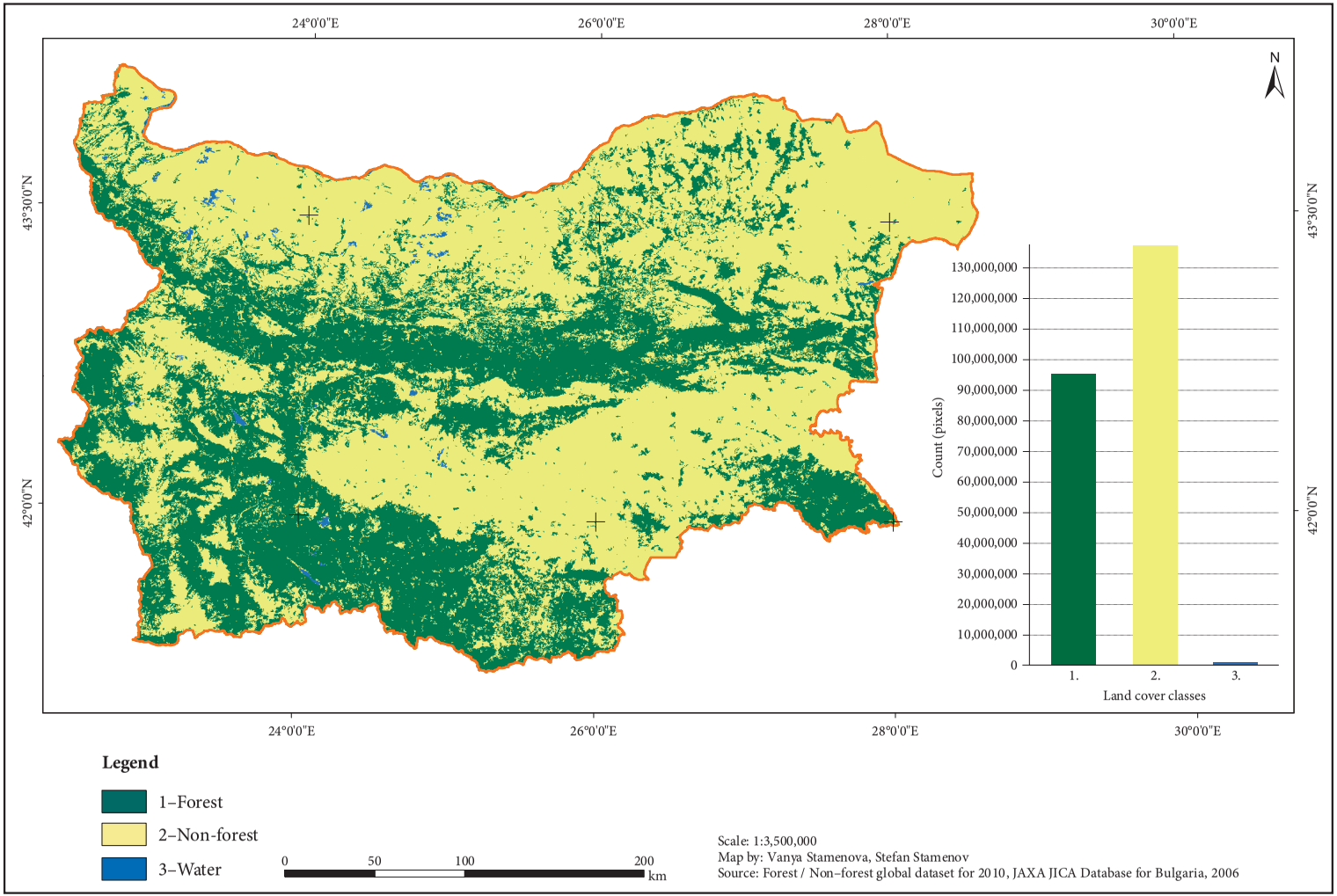

24°0'0"E
26°0'0"E
28°0'0"E
30°0'0"E
43°30'0"N
42°0'0"N
N
Count (pixels)
130,000,000
120,000,000
110,000,000
100,000,000
90,000,000
80,000,000
70,000,000
60,000,000
50,000,000
40,000,000
30,000,000
20,000,000
10,000,000
0
1.
2.
3.
Land cover classes
Legend
1–Forest
2–Non-forest
3–Water
0
50
100
200
km
Scale: 1:3,500,000
Map by: Vanya Stamenova, Stefan Stamenov
Source: Forest / Non–forest global dataset for 2010, JAXA JICA Database for Bulgaria, 2006

Table 5: Error matrix for Forest/Non-Forest dataset.

Land cover class (number of points)	Forest	Non-forest	Water	Total	User Accuracy (%)
Forest	156	41	0	197	79.2
Non-forest	32	149	3	184	81.0
Water	0	0	1	1	100.0
Total	188	190	4	382	0.0
Producer Accuracy (%)	83.0	78.4	25.0	0.0	80.1

3.4 Validation of the Tree Canopy Cover 2010 dataset

The tree canopy cover product for 2010 shows the tree cover in percentages from 0 to 100, for trees with height higher than 5 m. The map of the forests for the territory of Bulgaria generated using the tree canopy cover dataset is presented on Figure 8.

The validation for this dataset was made through visual interpretation and assigning true or false values (respectively 1 and 2) depending on the availability of forest for each sample unit. The estimated overall accuracy for the Tree canopy cover product is very high – 96.1%.

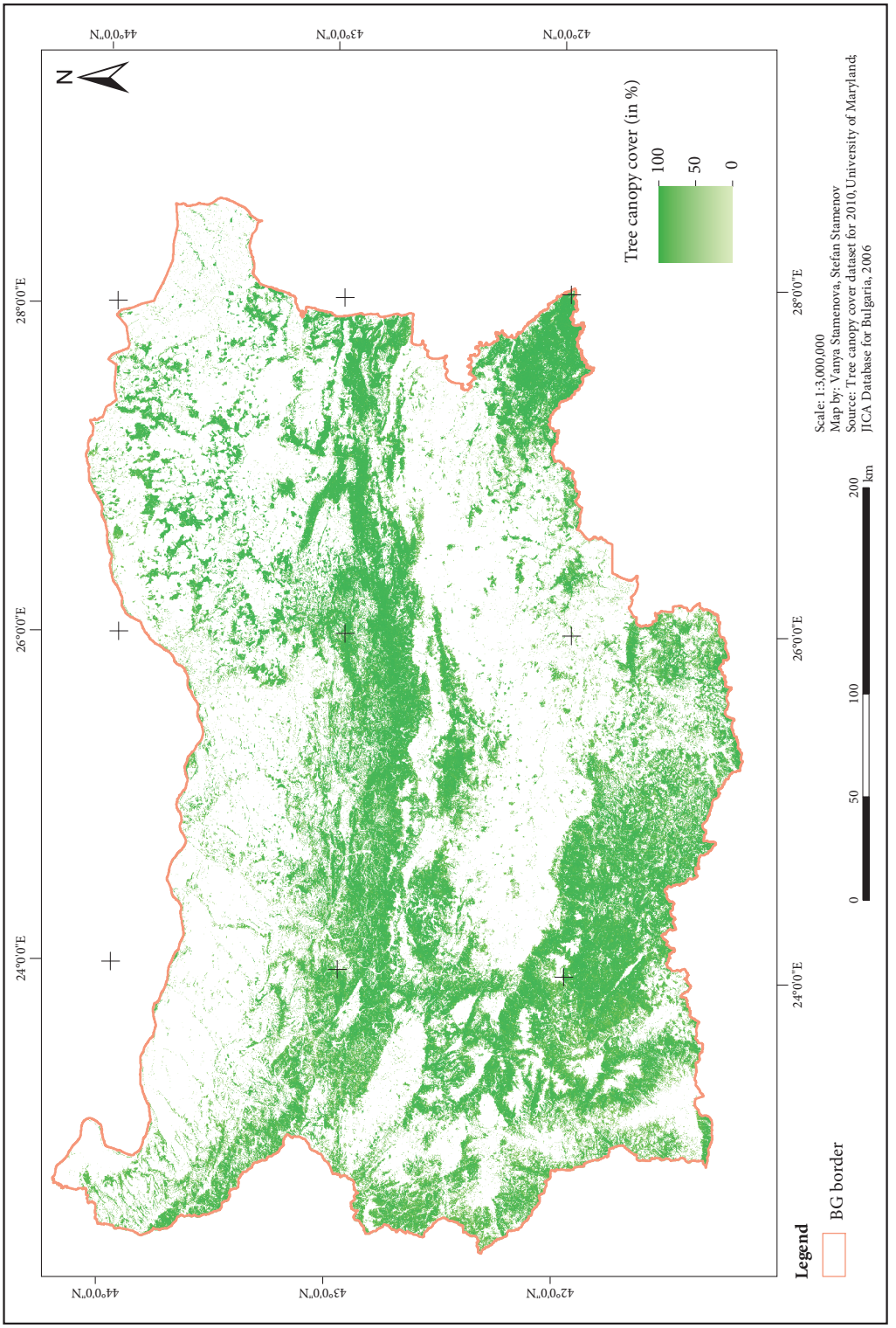
4 Discussion

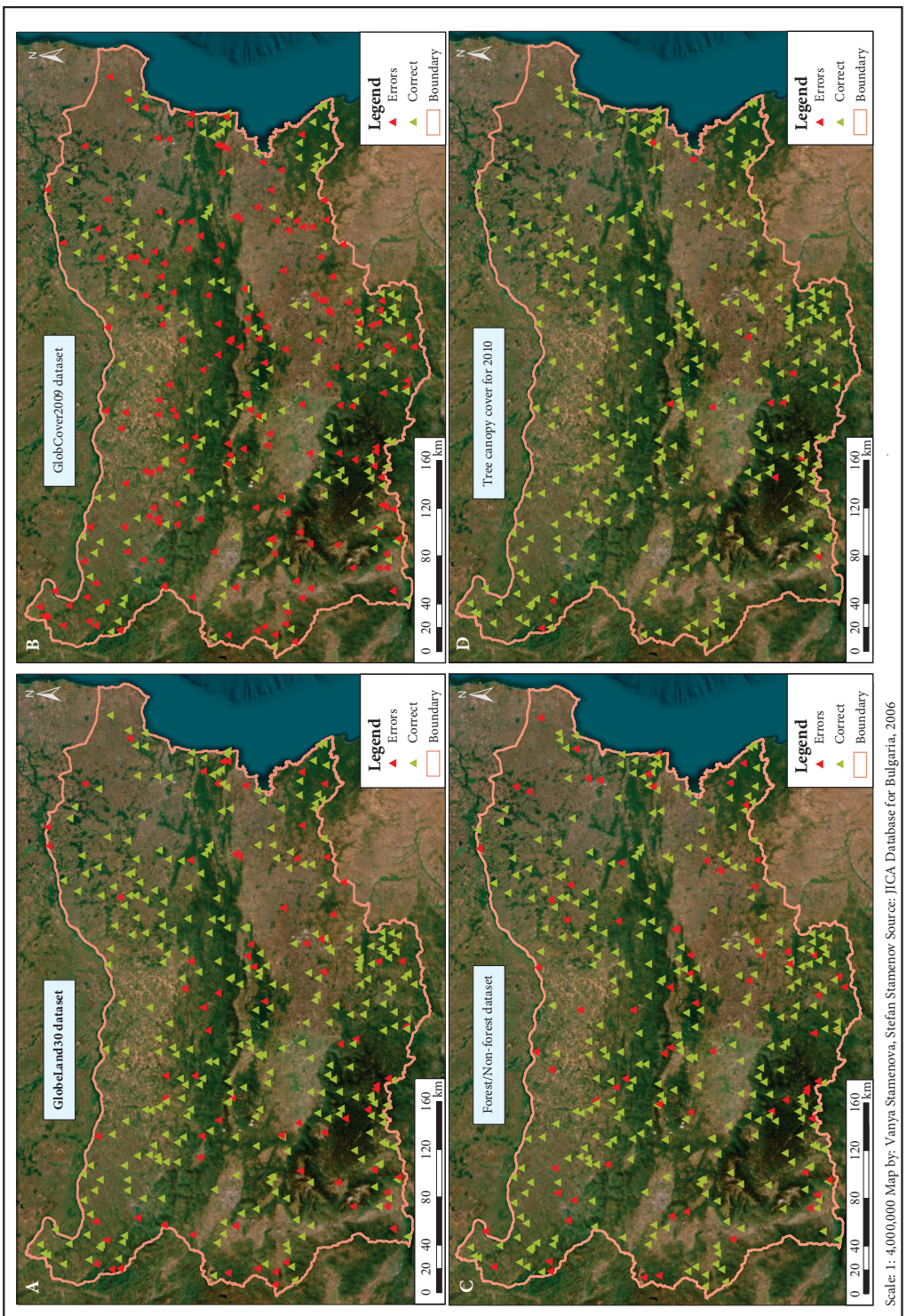
The validation results of the four global land cover datasets show that the highest accuracy is observed for Tree canopy cover (96.1%), the lowest for GlobCover 2009 (51.0%), and the other products' accuracy is considerably high – about 80%. Each of the four GLC products, which have been validated, has its own specifics, spatial resolution and thematic classes' structure and content of the classes. The products differ in their spatial resolution (from 25 to 300 m), in the used land cover classification system and the number of land cover classes. The pixel size affects the details of the land cover products, there is a functional relationship between the pixel size and number of the details at the land cover product. It is obvious that the bigger the pixel size, the lower the number of details will be. On the other hand, the validation is made with satellite and aerial images with high and very high spatial resolution, where a detailed representation of the earth surface is observed. The pixel size influence on the accuracy of the GLC, since when the pixel size of the product is bigger each pixel covers area, which is much more likely to be heterogeneous than for the products which have smaller pixel size and is more likely to decrease the accuracy of the product. Also, when we have a product with more classes it represents more complex information about the Earth surface but at the same time it is more likely the product to have mixed pixels, and thus to result in higher inaccuracies in the assignment of the land cover classes.

Differences exist also in the way of determining the classes for the different land cover products. The vegetation and cultivated land cover classes of the ESA GLC product are defined as compound classes with percent ratios between the different types of vegetation while the other three products have only unitary land cover classes. In the cases when we have compound classes, the validation using high resolution reference data for the mixed pixels is a reason for ambiguity in how to assess the percent presence of each presented class and to which compound class to assign the pixel. The lower estimated accuracy for the GlobCover 2009 product is related to the large number of mixed pixels and their incorrect assignment to related land cover class. The results of the validation confirm that registering lower per class accuracies (user and producer) for the compound land cover classes (Table 4). The validation of the product with unitary classes is characterized with more unambiguous assignment to land cover classes and more often, the mistakes observed in their classifications are due to the misclassified pixels from classes, which are very close and difficult to distinguish, e.g. grassland and cultivated land.

Figure 8: Map of the tree canopy cover for the territory of Bulgaria for 2010. ► p. 79

Figure 9: Distribution of the correctly classified pixels and error pixels on the territory of Bulgaria for each of the global land cover datasets: A – GlobeLand30 dataset; B – GlobCover2009 dataset; C – Forest/Non-Forest dataset and D – Tree canopy cover dataset. ► p. 80


N
44°0'0"N
43°0'0"N
42°0'0"N
24°0'0"E
26°0'0"E
28°0'0"E
Tree canopy cover (in %)
100
50
0
Legend
BG border
0
50
100
200
km
Scale: 1:3,000,000
Map by: Vanya Stamenova, Stefan Stamenov
Source: Tree canopy cover dataset for 2010, University of Maryland;
JICA Database for Bulgaria, 2006


A
GlobeLand30 dataset
B
GlobCover2009 dataset
C
Forest/Non-forest dataset
D
Tree canopy cover for 2010
Legend
Errors
Correct
Boundary
N
0 20 40 80 120 160 km
Scale: 1: 4,000,000 Map by: Vanya Stamenova, Stefan Stamenov Source: JICA Database for Bulgaria, 2006

The spatial distribution of the correctly classified and error pixels for each of the validated GLC datasets has been presented on Figure 9. As it's seen, the areas with high concentration of error pixels are the mountain and low-mountain regions in south and west Bulgaria – Rhodope, Kraishte and the central part of Stara planina (especially for Figure 9A and 9C), which are characterized with significant heterogeneity of the landscape and land cover. The error pixels for the GlobCover2009 are distributed comparatively equally over the territory of Bulgaria (Figure 9B), due to the large number of mixed pixels for this product. The errors for tree canopy cover are located also in the Rhodope Mountain area (Figure 9D).

The proposed method for validation of GLC datasets combines the capabilities of the online platform, the GIS processing techniques and functionality which is serious advantage and the interpretation of remote sensing and other supplementary data for assigning each of the sample units to the correct land cover class.

The main result product from the validation process is the created vector file, storing the information for the validation results of all examined datasets in its attribute table. This allows the obtained results to be stored in vector format, e.g. shapefile, which has small volume, high popularity and interoperability. This allows the available results from the already performed validation process to be used in future and allows the land cover classes for the sample units to be compared. In the land cover validation process visual interpretation stays as one of the most popular, effective and widespread methods. It is based on knowledge which every expert has (culture-based, nature-based knowledge), which provides the highest level of confidence (Chen et al. 2015; Zhang et al. 2016).

5 Conclusion

The presented article proposed an integrated method for land cover validation, which combines the GIS environment data integrity with classical expert knowledge-based method as visual interpretation with attempt to elaborate a determined and simple enough algorithm for visual interpretation, which can also be used in crowdsourcing approach for gathering and processing of information. The proposed method is designed as effective, time-saving and having a clear structure and sequence of the steps without being too complex.

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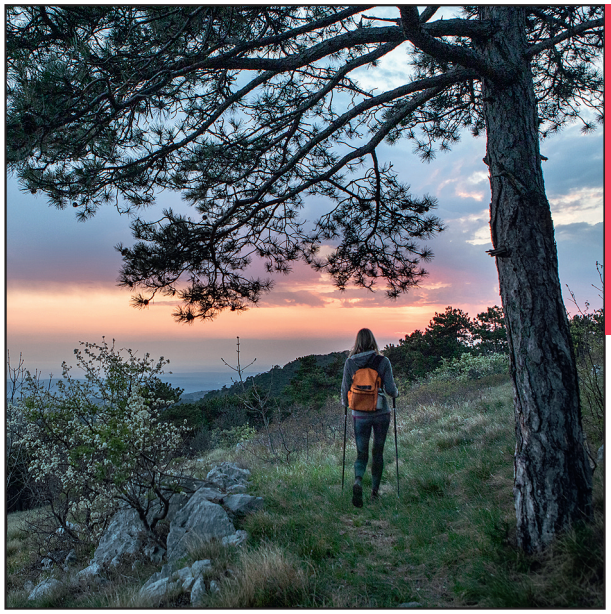
Acta geographica Slovenica, 62-3, 2022, 85–102

SUSTAINABLE CERTIFICATION OF A TOURIST DESTINATION THROUGH THE PRISM OF A VISITOR'S POINT OF VIEW

Matjaž Geršič, Primož Gašperič, Petra Rus, Mateja Šmid Hribar, Nika Razpotnik Visković



JOŠT GANTAR

Hiking on Trstelj, the highest hill in the Karst, which, together with Brkini, is included as a destination in the Green Scheme of Slovenian tourism.

DOI: https://doi.org/10.3986/AGS.11214
UDC: 91:338.48:502.131.1(497.4)
COBISS: 1.01

Matjaž Geršič[1], Primož Gašperič[1], Petra Rus[1], Mateja Šmid Hribar[1], Nika Razpotnik Visković[1]

Sustainable certification of a tourist destination through the prism of visitor's point of view

ABSTRACT: With the research we wanted to find out what are the tourism practices that tourists perceive as sustainable at tourist destinations in Slovenia that have the Slovenia Green sustainability certificate. We have selected eight destinations. The main method of work was surveying, followed by the analysis of the results. We analyzed 1444 surveys. We found that only 50% of respondents know about the sustainability certificate for tourist destinations, that the most recognizable sustainable practice in destinations is the possibility of using water for drinking from the tap, and that the biggest drawback in destinations is inadequate public passenger transport. We conclude that destinations should invest in more effective propaganda of the sustainability certificate and make more visible progress, especially in the field of public passenger transport.

KEY WORDS: Slovenia, tourism, certificate, sustainability, destination

Trajnostno certificirane turistične destinacije skozi prizmo obiskovalcev

POVZETEK: Članek prikazuje rezultate raziskave, s katero smo želeli ugotoviti, katere so tiste turistične prakse, ki jih turisti kot trajnostne dojemajo na slovenskih turističnih destinacijah s trajnostnim certifikatom Slovenia Green. Izbrali smo osem destinacij. Poglavitna metoda dela je bilo anketiranje, kateremu je sledila analiza rezultatov. Analizirali smo 1444 anket. Ugotovili smo, da trajnostni certifikat za turistične destinacije pozna le slabih 50 % anketirancev, da je najbolj prepoznavna trajnostna praksa na destinacijah možnost uporabe vode za pitje iz pipe ter da je največja pomanjkljivost na destinacijah neustrezen javni potniški promet. Ugotavljamo, da bi destinacije morale investirati v učinkovitejšo propagando trajnostnega certifikata in posebej na področju javnega potniškega prometa storiti vidnejši napredek.

KLJUČNE BESEDE: Slovenija, turizem, certifikat, trajnost, destinacija

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1 Introduction and theoretical background

The tourism industry in Slovenia has shown an average growth trend since 1991, when Slovenia declared its independency. The crisis with the pandemic Covid-19, of course, stopped this trend. The peak was reached in 2019, when 6,229,573 tourists visited Slovenia and generated 15,775,331 overnight stays. In 2019, the tourism industry employed 6.5% of the labour force and contributed 5.3% to GDP (Špik and Počuča 2020).

On the one hand, rapid growth of the tourism sector brings economic benefits but, at the same time, it means a greater burden on the environment and society (Fennel 1999; Mokry 2013; Stojanović et al. 2014; Dragićević et al. 2015). Some studies from the last decade have concluded that the risk of negative impacts of tourism development increases with the number of tourists, which in turn leads to lower tourist satisfaction with the experience and destination (Geneletti and Dawa 2009; Juutinen et al. 2011; Vasiljević et al. 2011; Navrátil et al. 2014). It also has a number of negative consequences for the quality of life of the local population (Moscarda 2011; Gravari-Barbas and Jacquot 2017; Koens and Postma 2017; Postma, Buda and Gugerell 2017). Some authors speak of the emergence of overtourism (Koens, Postma and Papp 2018; Rangus, Božinovski and Brumen 2018; World Tourism Organization 2018; Polajnar Horvat and Ribeiro 2019). A well-known approach of how to manage overtourism is through the concept of sustainability. This is based on four pillars: economic, environmental, socio-cultural and political participatory (Mihalic 2016; Knežević Cvelbar et al. 2021).

To counteract the negative externalities of tourism and enable sustainable development in tourism, there is an obvious need to develop green tourism strategies and products (Parsons and Grant 2007; Zelena shema … 2017). Individual destinations and suppliers can achieve this through standardization, certification, labelling, competition for awards and titles, and networking (Razpotnik Visković 2020, Ledinek Lozej and Razpotnik Visković 2022; Razpotnik Visković and Logar 2022).

Certification is also referred to as a »stamp of approval,« identified by labels, seals, certificates, brands or trademarks (Buckley 2002; Harris 2007) and is just one of the mechanisms available to tourism providers. Certification is the process by which an organization grants recognition to a person, organization, process, service or product that meets certain recognized and established standards (Conaghan and Hanrahan 2009). It can assure consumers that a product or service meets specific standards or measurable criteria, and this can increase customer confidence and satisfaction (Dodds and Joppe 2005). Certification has become an increasingly popular voluntary tourism management tool to meet both supply-side and demand-side requirements that go beyond regulatory requirements (Honey and Rome 2001). Certification has been shown to increase a company's credibility in world markets because of its public commitment to quality, safety and risk management, which leads to increased sales, competitiveness and profitability (Conroy 2001). Certification can raise the profile of a brand and/or destination, making it synonymous with sustainability, quality and/or safety (Honey 2002; Philpott et al. 2007). For these reasons, certification is often seen as a beneficial marketing tool for tourism operators (Adanur and Allen 1995; Ho 1994; Honey 2002). From a safety perspective, it makes sense for the system to provide for recertification after a few years. The result of certification is a certificate, which is a document between the company conducting the assessment and the applicant (company or destination). It can be said that certification guarantees a holistic approach and long-term sustainable performance. The communication with the final consumers is called labelling (Figure 1) (The concepts … 2003; European … 2018; Rangus, Božinovski and Brumen 2018; Razpotnik Visković 2020).

There are different types of certificates in tourism; they can be national or global, and they can be linked to the destination as a whole or to a single supplier. Each type of supplier can have its own certificate (e.g., hotels or beaches).

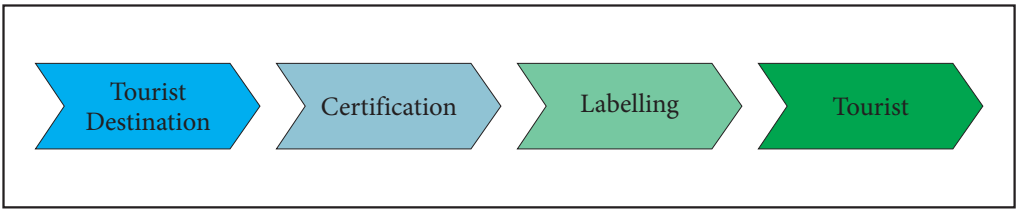


Figure 1: Position of certification and labelling in the communication between destination and tourist (Razpotnik Visković 2020).

It is therefore not surprising that in 2002 there were more than 100 green tourism certification schemes worldwide (Jarvis, Weeden and Simcock 2010). In the Labelscape project, we identified 30 certificates for tourism destinations that correspond to Global Sustainable Tourism Council criteria (hereafter: GSTC) (Global Sustainable … 2022) and Sustainable Development Goals (Sustainable development … 2022).

A discourse has recently developed on the subject of certification in tourism. The most comprehensive of these studies is Pennington-Gray et al. (2014). It can be seen that the focus has been on eco-certification in the past. The exact process of six-step ecological certification in tourism was defined by Sasidharan, Sirakaya and Kerstetter (2002), and it can also be used for other types of certification in tourism. The ecological aspect is also emphasized by some other authors, such as Janjuševič and Perovič (2020).

Another group of studies has focused on assessing customer perception and awareness of certified hotels (e.g., Penz, Hofmann and Hartl 2017; Martínez García de Leaniz, Herrero Crespo and Gómez López 2018; Spenceley 2018; Martínez, Herrero and Gómez - López 2019; Agudo et al. 2021; Nelson et al. 2021).

Font (2002) found that awareness and familiarity with eco-labels in the tourist sector is generally low. It may partially result from confusion due to the current proliferation of labels and certifications. This confusion may further lead consumers to ignore green messages. On the other hand, consumers may be unaware of eco-labels in the tourist sector, since the majority of consumers do not consider sustainability issues (particularly environmental ones) when planning their holiday (Budeanu 2007; Erskine and Collins 1997; Fairweather, Maslin and Simmons 2005; Resier and Simmons 2005). Generally, the concept of traveling and holidays is (still) not linked to sustainability (Penz, Hofman and Hartl 2017). Nevertheless, Janjuševič and Perovič (2020) claimed in their study that potential consumers are willing to pay up to 40% (which does not mean that they actually paid) more for services of eco-certified units, since their principal benefit is in added value. In the case of tourists on Gili Trawangan in Indonesia, the percentage of such tourists was more than 70% (Nelson et al. 2021).

The third group consists of articles about selected tourist activities linked to certification (culinary, beach, festivals …). For example, Ratnasari et al. (2020) found that halal certification does not affect customer satisfaction, but it does affect behavioural intention. Dodds and Holmes (2020) concluded that the majority of beachgoers are aware of the certificate but do not know what it means. Another study (Chirieleison, Montrone and Scrucca 2022) highlighted that certification is only the first step, since tourists who were aware of the label tended to have relatively positive perceptions and higher satisfaction compared to those who were not. Two articles have addressed certified wildlife activities. Lissner and Mayer (2020) found that most tourists were willing to pay more money to travel with a certified tour operator. Lawton and Weaver (2009), on the other hand, claimed that certification can promote sustainable practices in the management of bird festivals. National park certification has been studied in terms of how sustainability standards can be used to support protected area management for tourism (Bushell and Bricker 2017) and the lack of response to ecolabeling in certified protected areas in Finland (Puhakka 2010).

There have been few studies concerning certification at the destination level. Grapentin and Ayikoru (2019) highlighted the strengths and weaknesses of the systems currently in use, including various factors that could influence their future development. In particular, the study concluded that destination rating and certification is affected by four key factors: practicality, reliability, visibility and (non)availability of incentives. The salience of these issues and their resulting complexity influence the way tourists and tourism destinations deal with destination rating and certification. This narrows the opportunities and limitations of such systems. Pennington-Gray et al. (2014) focused on certified, crisis-prepared destinations in the United States, while Wambugu Maingi (2019) indicated that tourism certification and accreditation systems in East Africa are one of the most important tools in dealing with overtourism in the East African context.

It can be concluded that the literature on the demand side is sparse and, consequently, very little is known about how consumers perceive tourism certification and how their perceptions of a destination and travel decisions may be influenced by destination certification.

The few studies that have looked at consumer demand for certification have focused primarily on pricing, the relationship between quality and certification, and willingness to travel (e.g., Chafe 2005; Fairweather, Maslin and Simmons 2005; Rivera 2002). In this article, we will focus on certification from the tourist's point of view.

We will therefore focus on two main research questions in this article:
RQ1 – Are visitors familiar with the Slovenian sustainable tourism certificate?
RQ2 – Which tourism practices are recognized by visitors as sustainable?

1.1 Slovenia Green

Slovenia Green is a national sustainable tourism certificate, established in 2015 and managed by the Slovenian Tourist Board (Priročnik … 2021). It was created in the frame of The Green Scheme of Slovenian Tourism, a national supporting programme for developing sustainable tourism on the level of destination and service providers (Weston et al. 2018). Entities that can become certified are destinations, protected areas, accommodations, tour operators, restaurants, attractions and beaches. Certification of the service providers is relatively simple and is based on recognising endorsed existing sustainable tourism certificates (see Table 1). When a business obtains one of these certificates (primary certificate), it can also apply for the Slovenia Green certificate (secondary certificate) without any additional evaluation.

Certification of destinations (individual municipality or group of municipalities) and protected areas is more complex since the process involves a greater number of local actors, e.g., Destination Management Organisations (hereafter: DMO), local tourism authority (often acts as the DMO but not always), providers of communal services, NGOs, associations, tourism providers and/or their interest groups. Destinations and protected areas need to be in compliance with the GSTC recognized Green Destinations standard but are supported in the process of certification by the Slovenian Tourism Board, which provides training, workshops and internet counselling (Poziv k oddaji … 2022).

The number of certified entities has been increasing annually. In 2022, the number of certified entities was as follows: 58 destinations, 4 protected areas, 99 accommodations, 8 travel agencies, 6 attractions, 40 restaurants and 1 beach (Green Scheme of … 2022a). In other words, certified destinations cover approximately ⅓ of Slovenian territory (75 municipalities) and 75% of tourism volume, namely overnight stays in the pre-pandemic year 2019 (Prihodi in prenočitve … 2019).

The process of certification lasts approximately 10 months and the certificate is valid for three years. Destinations can be awarded bronze, silver, gold or platinum signs, depending on their sustainability performance. In this 3-year period of certificate validity, destinations need to continue with activities in the field of sustainable tourism development and ideally show progress during the re-certification evaluation, which results also in a more valuable sign colour. However, the opposite can also happen – the destination can regress in colour or even lose the certificate.

One of the important elements of Slovenia Green certification for the destination is the inclusion of local inhabitants, local tourism businesses and visitors in the activities. Each destination that enters the (re-) certification process must carry out surveys with these three groups in order to take into consideration their perceptions of local tourism and include their expectations in the tourism strategy of the area.

Destinations are autonomous in implementing this task, but for those that need support, the Slovenian Tourist Board has prepared three different questionnaires (including an online version) adapted to each group: local inhabitants, local tourism businesses and visitors. The research presented in this article is based on questionnaires for visitors to the destinations.

Table 1: Primary certificates endorsed by the Slovenian Tourist Board (Poziv k oddaji . . . 2022).

Endorsed certificate (primary certificate)	Slovenia Green Category (secondary certificate)
Bio Hotels, Ecocamping, EU Ecolabel, Green Globe, Green Key, Travelife, World of Glamping Green, Hostelling International Quality & Sustainability	Slovenia Green Accommodation
Travelife, Green Globe	Slovenia Green Travel Agency
Green Globe, Green Key	Slovenia Green Attraction
Blue Flag	Slovenia Green Beach
L.E.A.F., Green Key	Slovenia Green Cuisine

2 Methods and study area

2.1 Questionnaire development and data analysis

The analysis of visitors' perceptions of a destination's sustainability performance is based on a visitors' survey carried out by (re-)certifying destinations in 2021. According to the Slovenia green certificate rules destinations need to carry out surveys with visitors and, for this purpose, can use questionnaires proposed by the Slovenian Tourist Board (Priročnik … 2021). The authors of this study upgraded the questionnaires and the survey was implemented by DMO. The questionnaire comprises four groups of questions and evaluations (Table 2):

- general information about their visit (e.g., number of nights in destination, motivation for traveling);
- evaluation of their experience at the destination on a Likert scale from 1 to 5 (e.g., accommodation, gastronomy, shopping, public transport, health & security);
- evaluation of sustainable practices at the destination on a Likert scale from 1 to 5;
- general demographic information about the visitor (e.g., age, sex, country of residence).

Based on the data collected in the survey, we prepared statistical analyses with descriptive statistics calculations and displayed the selected results with the help of charts.

Table 2: Questions in the questionnaire.

Groups of questions/evaluations	Question/Evaluation
General information about their visit	Who are you travelling with?
	How many nights will/did you spend in our destination?
	Which mode of transport will/did you mostly use during your visit to our destination (select only one option)?
	What is the main motive of your visit?
	Are you familiar with Slovenian label for sustainable tourism Slovenia Green?
Evaluation of experience at the destination	Possibility to travel by foot or riding a bike. Public transportation.
	Well-kept surroundings.
	Health care and health protection.
	Opportunities for hiking and cycling.
	Cultural offer (museums, galleries, cultural events . . .).
	Kindness and hospitality of local people.
	Personal safety during the visits.
	Value for money.
Evaluation of sustainable practices at the destination	Destination is providing enough information about the local gastronomic offer and local products. In destination, it is safe to drink tap water.
	In destination, there are enough waste separation points available.
	Destination is providing enough information about reducing water and energy consumption.
	Destination stimulates visitors to use sustainable modes of transport (cycling, walking, train, bus . . .).
	Destination is providing enough information about health concerns and accessibility to medical care.
	Destination is providing enough information about how to act responsibly (while visiting attractions, during events ...).
General demographic information	Age.
	Gender.
	Employment status.
	Country of your residence.

2.2 Data collection and study area

The survey was carried out by DMO in the destination (Table 3; Table 5), either in person or through an online questionnaire. The most common locations for addressing visitors (Table 4) were tourism offices, accommodations or attractions.

In the instructions for the use of these questionnaires, DMOs were instructed to follow quota sampling for their survey, and to adjust their sample in a way that corresponds best to the number of visitors and their origin, sex and age group. They were advised to calculate the size of the sample by using online calculators, e.g., surveymonkey by entering the total population size (population is the average annual number of visitors), a 95% confidence level and 5% margin of error.

It should be added that surveying was carried out during the time of the Covid-19 epidemic, so all sampling requirements could not be respected due to the prevalence of home visitors over foreign tourists and decrease in tourism volume in some destinations (in comparison with 2019; Turizem v številkah 2020). Surveys were carried out from April until December 2021. Criteria for inclusion of the destination in our analysis were geographical diversity (located in different parts of Slovenia), different types of tourism offer (seaside tourism, urban tourism, wellness tourism …) and different levels of sustainability performance (bronze, silver, gold).

Table 3: Destinations included in our analysis (Poziv k oddaji . . . 2022; Vrste turističnih občin . . . 2022).

Destination	No. of municipalities	No. of respondents	Statistical region	Slovenia Green sign (in 2022)	Type of tourism
Kranj	single	329	Gorenjska	gold	urban
Kras-Brkini	group	337	Obalno-kraška	gold	other
Krško	single	78	Posavska	gold	other
Laško	single	110	Savinjska	gold	wellness
Ljutomer	single	66	Pomurska	bronze	other
Murska Sobota	single	397	Pomurska	bronze	wellness
Piran - Portorož	single	82	Obalno-kraška	bronze	seaside
Postojna	single	45	Primorsko-notranjska	silver	other

Table 4: Socio-demographic characteristic of respondents (n = 1444).

Demographic variables		Frequency (n)	Valid percent
Age	less than 25	229	16%
	25–44	508	35%
	45–64	505	34%
	65 or more	222	15%
Gender	female	769	53%
	male	695	47%
Employment status	student, pupil	201	14%
	employed, self-employed	962	66%
	retiree	270	18%
	other	31	2%
Country of residence	Slovenia	956	65%
	Bordering countries	152	10%
	Other European countries*	315	22%
	Other countries	41	3%

*Russia and Türkiye are included in the group of other countries.

Figure 2: Map of included destinations. ► p. 92

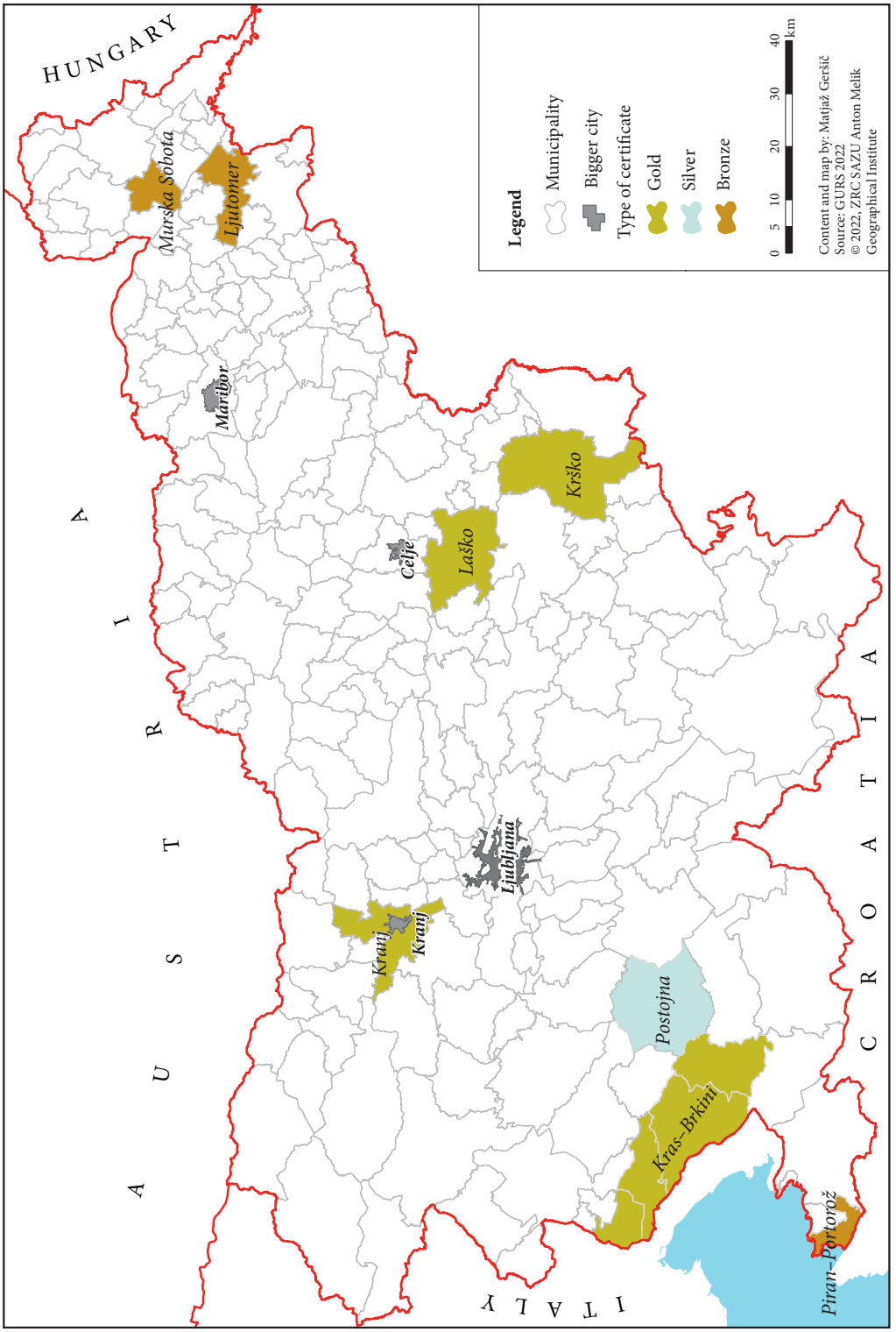

HUNGARY
AUSTRIA
ITALY
CROATIA
Murska Sobota
Ljutomer
Maribor
Celje
Laško
Krško
Ljubljana
Kranj
Kranj
Postojna
Kras–Brkini
Piran–Portorož
Legend
Municipality
Bigger city
Type of certificate
Gold
Silver
Bronze
0 5 10 20 30 40 km
Content and map by: Matjaž Geršič
Source: GURS 2022
© 2022, ZRC SAZU Anton Melik Geographical Institute

Table 5: Characteristics of the destinations (*data missing for April 2021; ** data missing for April 2020).

Destination (number of respondents)	Type of certificate (year of acquisition of the first certificate)	Area [km^2]	Inhabitants	Nights spent by citizens / share				Nights spent by foreigners / share			
				2018	2019	2020	2021	2018	2019	2020	2021
Kranj (329)	gold (2022)	150.9	57,185	9031 / 7%	7584 / 6%	7759 / 20%	11,629 / 22%	119,479 / 93%	113,783 / 94%	31,340 / 80%	40,791 / 78%
Kras-Brkini (337)**	gold (2017)	660	26,642	20,557 / 12%	19,549 / 11%	36,390 / 47%	60,197 / 50%	152,923 / 88%	158,403 / 89%	41,667 / 53%	60,469 / 50%
Krško (78)**	gold (2021)	286.5	25,904	7608 / 31%	4517 / 27%	4855 / 43%	7276 / 38%	16,784 / 69%	11,925 / 73%	6538 / 57%	11,975 / 62%
Laško (110)	gold (2016)	197.5	13,123	12,5665 / 43%	88,837 / 38%	10,1397 / 73%	151,616 / 78%	164,132 / 57%	146,350 / 62%	38,317 / 27%	42,432 / 22%
Ljutomer (66)	bronze (2017)	107.2	11,233	48,733 / 76%	51,251 / 75%	51,086 / 93%	62,770 / 85%	15,689 / 24%	17,056 / 25%	3666 / 7%	11,289 / 15%
Murska Sobota (397)	bronze (2021)	64.4	18,622	31,627 / 62%	31,026 / 60%	20,322 / 84%	25,762 / 79%	19,055 / 38%	20,901 / 40%	3979 / 16%	6749 / 21%
Portorož-Piran (82)	bronze (2021)	44.6	18,457	589,624 / 31%	583,802 / 31%	873,084 / 69%	992,348 / 64%	1,292,759 / 69%	1,290,660 / 69%	399,858 / 31%	546,324 / 36%
Postojna (45)*	silver (2019)	269.9	16,675	15,203 / 9%	11,385 / 7%	16,346 / 36%	20,736 / 29%	149,222 / 91%	153,913 / 93%	28,732 / 93%	51,035 / 64%

3 Results

Guests spent an average of 2.6 nights at destinations, and the main purpose of their visit was to visit natural and cultural attractions, followed by rest and recreation. The least number of guests visited the destination for shopping, health services and education.

3.1 Familiarity with the Slovenian certificate for sustainable tourism Slovenia Green

In general, the Slovenian sustainable tourism certificate Slovenia Green was known to fewer than 50% of respondents although there were some slight differences depending on certain tourist characteristics.

The majority of respondents (62%) used cars during visits to the destination. Exactly half of them were familiar with the certificate. In the case of tourists who used other types of transport in their destination, there were some differences identified. Among those who used buses, 47% knew the certificate and slightly more, 55%, among those who cycled around the destination knew the certificate. Among those who walked, only 37% knew about the certificate. The certificate was most recognizable by those tourists who used trains to travel to the destination. It should be noted, however, that these were the least of all visitors (only 1%).

Comparing domestic and foreign tourists, 61% of domestic tourists knew the certificate and only 24% of foreign tourists.

The difference between recognition of the certificate among tourists traveling alone, with family, friends or otherwise was negligible. There was more than a 5% difference between knowledge of the certificate only between those visitors who were travelling with friends or alone, and between those who chose the category other.

Depending on the purpose of visiting the destination, there were somewhat larger differences between visitors who were aware of the certificate and those who were not (Figure 3). The biggest difference between those familiar with the certificate and those not familiar with it was among visitors whose main purpose for the visit was business visit – only 36% of them knew the certificate, and 64% did not. Among those whose main purpose of the visit was health and medical care, 60% know the certificate and 40% did not. There were also noticeable differences between those who travelled to the destination to visit friends and acquaintances (57% of them knew the certificate) and those who came for entertainment and gastronomy (only 45% of them knew the certificate).

Based on the length of stay at the destination, 60% of one-day visitors to the destination knew the certificate, but only 42% of those who stayed at the destination up to three nights, and half of those who stayed longer.

3.2 Tourism practices recognized as sustainable among visitors

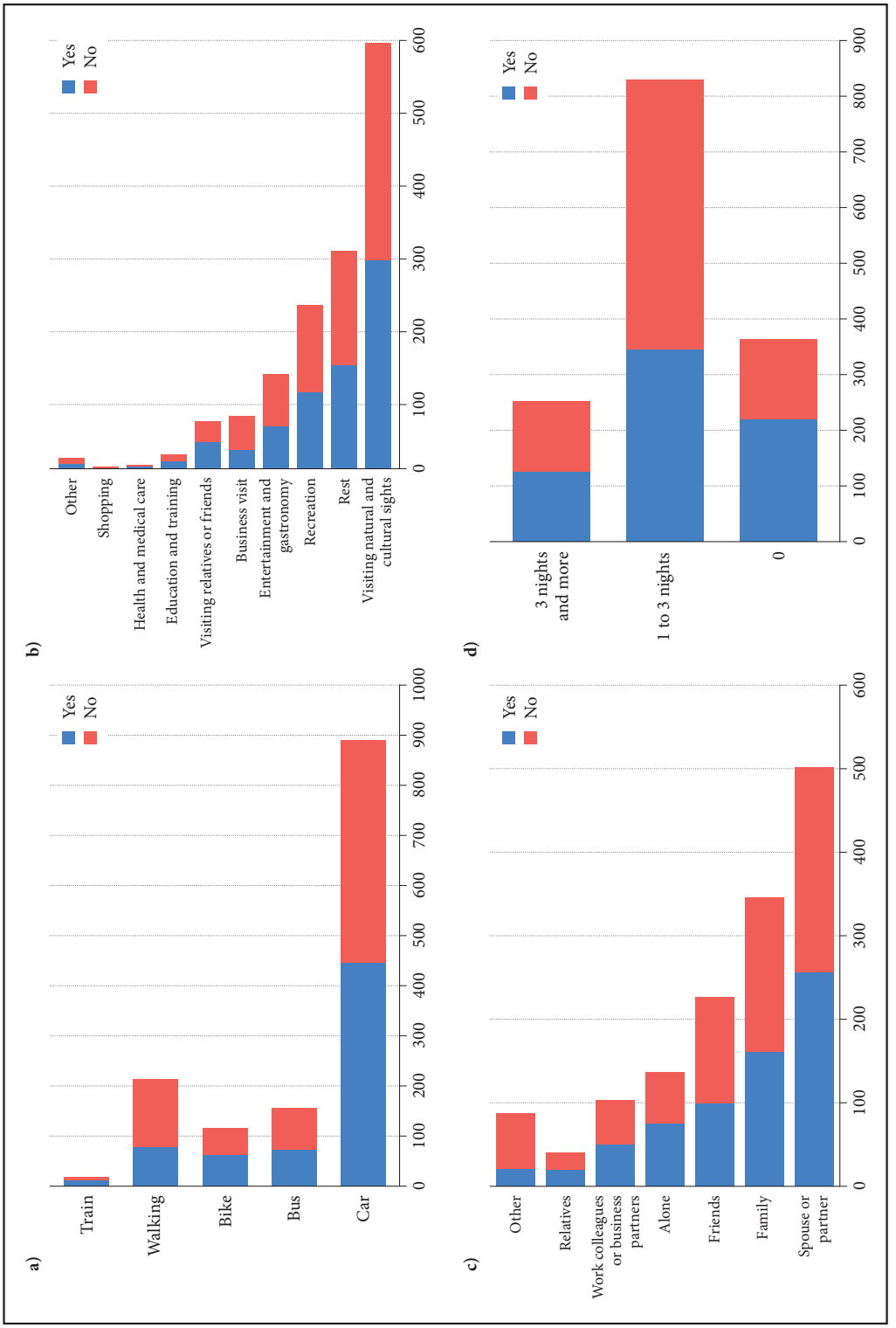
Of guests who spent an average of 3 to 4 days at the visited destination, 70% were transported by personal vehicles, 77% came from Slovenia and 40% came to the destination to visit natural and cultural attractions. Visitors rated the possibility of drinking tap water as the most recognizable at the destination (4.6/5) (Figure 4). Visitors also agreed with the statements that there are enough places to separate waste at the destination and enough information on how to behave responsibly (4.3/5).

They rated the destinations' efforts somewhat worse in terms of sufficient information about the local gastronomic offer and local products (4.2/5), sufficient incentives for the use of sustainable forms of transport (4.1/5), and a sufficient amount of information about healthcare and access to medical care (4.1/5).

According to the visitors the least attention was paid to the information on saving energy and water as sustainable practice (3.9/5).

Comparing the perception of sustainable practices between domestic and foreign tourists, only small differences were found. The biggest difference was observed in the category »in destination, there are enough waste separation points available«. Foreign tourists were more satisfied (4.26/5) with these incentives than

Figure 3: Familiarity with the Slovenian certificate for sustainable tourism Slovenia Green in relation to the type of transport during the visit (A), the main motive of the visit (B), who they were traveling with (C), and how many nights were spent in the destination (D). ► p. 95


a)
Train
Walking
Bike
Bus
Car
Yes
No
0
100
200
300
400
500
600
700
800
900
1000
b)
Other
Shopping
Health and medical care
Education and training
Visiting relatives or friends
Business visit
Entertainment and gastronomy
Recreation
Rest
Visiting natural and cultural sights
Yes
No
0
100
200
300
400
500
600
c)
Other
Relatives
Work colleagues or business partners
Alone
Friends
Family
Spouse or partner
Yes
No
0
100
200
300
400
500
600
d)
3 nights and more
1 to 3 nights
0
Yes
No
0
100
200
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900

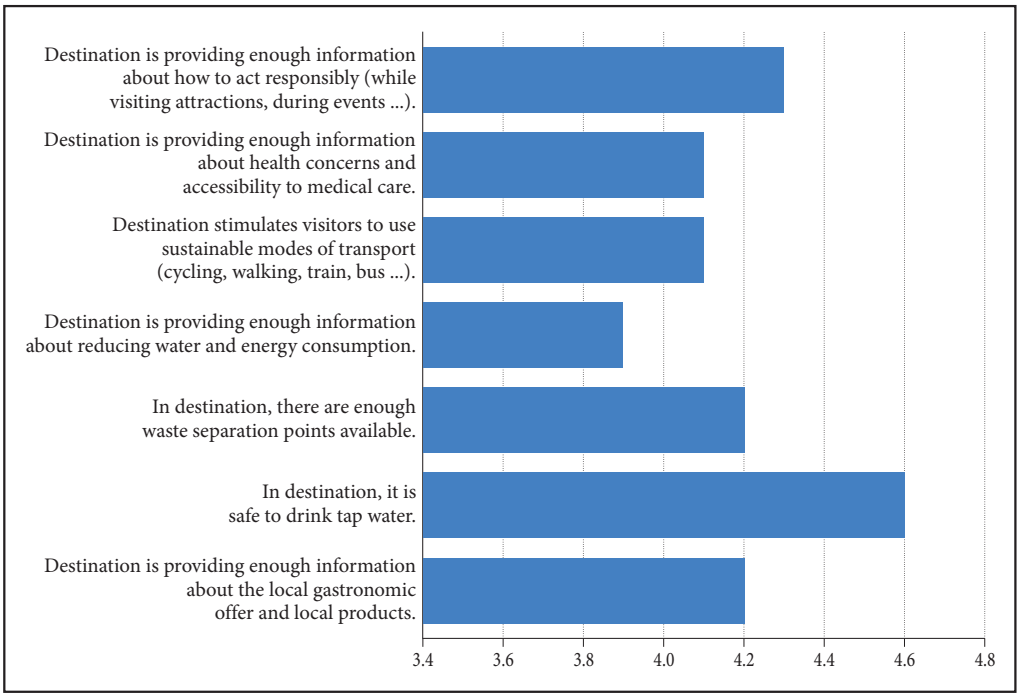

Figure 4: Assessments of destinations' sustainability efforts.

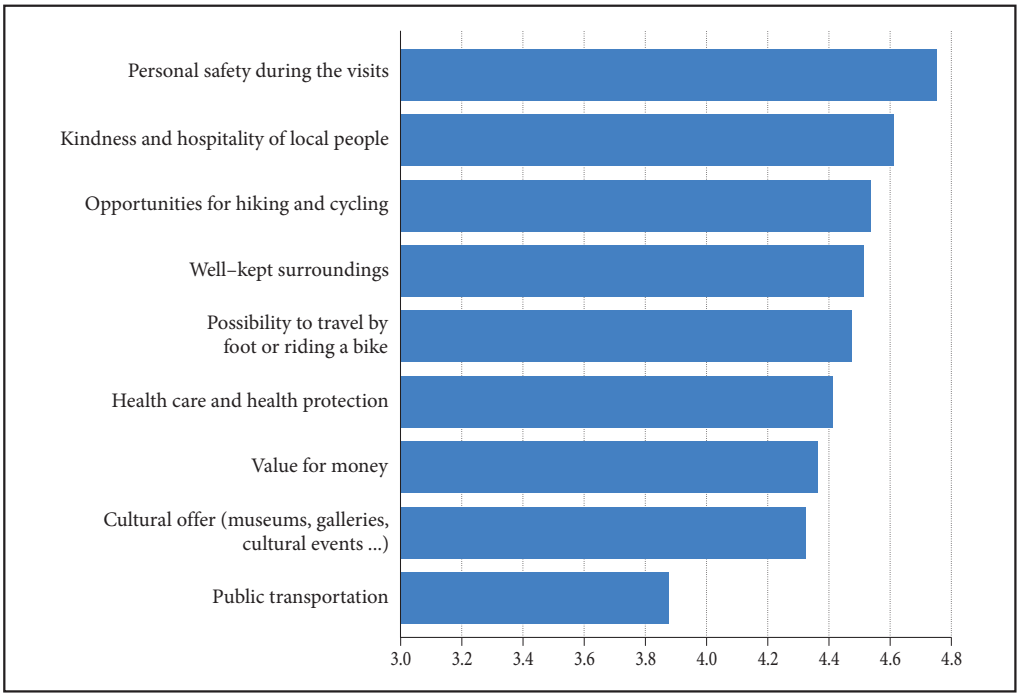

Figure 5: Reviews of some sustainability-oriented experiences at the destinations.

domestic tourists (4.24/5). This shows that, from the point of view of foreigners, such incentives still need to be further refined.

The question is also raised of whether the type of certificate or the tradition of the certified destination affects the assessment. The hypothesis that the best-rated destination would be the one with the longest tradition of certification or the one with the highest level of certification can be at least partially refuted. According to the analyses the best-rated destinations were those with silver (4.4/5) and gold signs (4.2/5), while the worst were those with bronze (4.1/5). In terms of the tradition of certification, it can be concluded that only this can influence the level of perception of sustainable practices. It appeared that the better-rated destinations were those that obtained the first certificate in 2019, 2016 and 2017, while the less well-rated were destinations that obtained the first certificate in 2021 and 2022.

Personal safety during the visit received the highest rating (4.8/5) at the evaluations of some experiences at the destination (Figure 5) that also reflect sustainable tourism practices according to the UN Environmental Program and UN World Tourism Organization. Kindness and hospitality of local people (4.6/5) were also rated highly. Among the destinations, the Kras-Brkini destination received the highest rating for personal safety (4.9/5), while the Piran-Portorož destination received the worst (4.6/5). Value for money (4.4/5) and cultural offer (4.3) received worse ratings. By far the worst rated was public transport (3.9/5). Comparing the ratings among the destinations, the worst rated destination for public transport was Kras-Brkini (3.2/5), and the best was Postojna (4.4/5). The poor evaluation of the destination Kras-Brkini is somewhat surprising, since it is one with the majority of activities focused on sustainable mobility (automatic e-bike sharing system, tourist bus) (Sustainability report 2021). The cultural offer was also poorly rated. The worst of the destinations were Laško and Piran-Portorož, and the best was Kranj. Kranj does not otherwise indicate a special emphasis on the cultural offer. There were also relatively poor value-for-money ratings for destinations. The worst-rated destination was Piran-Portorož, and the best was Postojna.

4 Discussion

The first fact that cannot be overlooked is that the certification was known to only a modest half of respondents. This has similarly been noted by some other authors (for example, Font 2002; Budeanu 2007; Erskine and Collins 1997; Fairweather, Maslin and Simmons 2005; Resier and Simmons 2005; Penz, Hofman and Hartl 2017).

Comparing recognition of the certification depending on the tourists' origin, the certification was best known to domestic guests, 60%. Only 28% of guests from neighbouring countries were aware of the certificate, this is similar to guests from other European countries, while only 13% of guests from the rest of the world were aware of the certificate.

An important aspect of sustainability is the mode of travel. In the research, the method of travel at the destination itself was determined and not the method of arrival to the destination. Slightly less than two-thirds of visitors used a private car to travel to the destination, which is the least sustainable form of travel. Walking and using the bus followed with 15%. Only 8% of visitors used bicycles. Comparing the engagement of destinations in raising awareness of the use of public passenger transport at destinations (Sustainability report 2021; Sever 2022; Destinacija Postojna 2022; Green scheme of … 2022b; Laško 2022; Murska Sobota 2022; Trajnostno poročilo … 2022; Prlekija 2022), it can be concluded that the effect is poor. However, it is necessary to distinguish between propaganda or awareness-raising and actually well-organized public transport. It is possible that the destinations do not do enough and, due to insufficient flexibility and still too infrequent public transport, visitors are forced to use their own vehicles to make good use of their time.

Guests also highlighted in the survey the topic of public transport as one of the worst sustainability efforts at destinations. Similarly, visitors rated poorly providing enough information about health concerns and accessibility to medical care.

Among the best-rated sustainable efforts, visitors highlighted the possibility of drinking tap water. It is a credit rating offered by Slovenia as a whole and is not the result of any special efforts at certified destinations. In year 2022, however, due to the high summer temperatures and drought, it has become clear that even this natural privilege may be absent in the future, especially in coastal and highland Slovenian regions (Podnebne spremembe 2021).

Our study found that guests considered concern for reducing water and energy consumption to be the worst sustainability effort at the destinations, and that visitors were insufficiently informed and warned about it. This is in the exclusive domain of the destination as such.

A moderately committed effort in the field of sustainability was perceived by visitors in terms of the sufficient number of places for separate waste collection and in terms of providing enough information about the local gastronomic offer and local products.

Visitors also rated good information about how to act responsibly (while visiting attractions and during events …) as a very appropriate effort in the field of sustainability.

Grapentin and Ayikoru (2019) noted that the most important factor when choosing a destination was the safety of the destination. This is also important from a sustainability point of view. Based on the good evaluation of visitors to the destinations in question, we have to maintain this benefit. The authors also noted that cultural offers come next in importance. Judging by our analysis, selected destinations must place greater emphasis on this area and confirm and improve it. Price is also important for visitors. Selected destinations still have some room for manoeuvre in this area as well. As noted by Sasidharan, Sirakaya and Kerstetter (2002) and Janjuševič and Perovič (2020), ecology was a very important aspect in the past. Judging by our analyses, this aspect is no longer in the forefront in the frame of sustainable tourism but remains among the more important elements.

As an additional result our research found out that with relation to sustainable practices among individual destinations, the difference between the best and worst was estimated at 0.6 on average.

4.1 Limitation

In terms of interpretation of the results, it should be emphasized that the survey was conducted in 2021/2022 when the consequences of the global pandemic of the Covid-19 virus were being felt. In tourism in Slovenia, this was mainly reflected in the above-average number of domestic tourists, which was the result of individual restrictions on departures abroad and tourist vouchers, which the state allocated to the population to save the tourism sector from collapse. It was therefore an atypical tourist season (Gössling and Schweiggart 2022), which of course is also reflected in the survey results. Although we understand that sustainability consists of several different pillars, in our study we focused on the environmental and social aspects which remains a gap for the future studies.

5 Conclusion

In relation to recognition of sustainability certificates, the results of our research do not deviate from related previous research in other geographical areas. The question naturally arises of how to achieve greater recognition of a sustainability certified destination among visitors and, at the same time, encourage visitors to perceive such a destination as an offer with a higher added value. First of all, more effort and resources should probably be devoted to the promotion of such destinations, especially among foreign visitors. In terms of the resources invested in the certification process and adjustments related to it, the area of promotion should also not be neglected. Another aspect is related to consumer education. For them to be aware of the added value of sustainability certified destinations, they should probably learn more about the concepts through the educational process.

Another aspect that should be noted is public passenger transport. It is generally recognised that public transport is not the best developed in Slovenia because, in past decades, huge investments were made in the construction of the highway network, while the railway network was largely forgotten (Tiran, Hrvatin and Gabrovec 2021). However, it is also true that, within an individual destination, perhaps more than the network in general, it is worth pointing out the challenges associated with the offer of public transport within a destination. These are often in the domain of individual municipalities. Comparing the engagement of individual destinations in the field of public passenger transport, which results from a destinations literature review and the responses of visitors, public transport was identified as a key obstacle. Destinations invest a lot of energy in arranging the offer (especially the bicycle offer), but visitors do not notice or do not use it. Perhaps the reason for the poor response to the offer is a large proportion of domestic guests.

Without a doubt, more care should be taken to inform visitors about saving water and energy, and destinations should improve the cultural offer and continue to maintain a high level of sense of security.

As we noted, the type of certificate (gold, platinum) is not directly proportional to the promotion of sustainable practices in the destination but is much more dependent on the tradition of a sustainable destination.

Finally, it should be noted that an excessive number of tourists causes overtourism (Koens, Postma and Papp 2018; Rangus, Božinovski and Brumen 2018; World Tourism Organization 2018; Polajnar Horvat and Ribeiro 2019), which undoubtedly does not contribute to the sustainable direction of destinations. Above all, this is a serious challenge for the local population, who should and must be an equal stakeholder in the space. Finding the right balance between the number of conscious tourists and ensuring the concept of sustainability remains an important aspect that must be addressed by certified destinations.

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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.

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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.

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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 two or more peer reviewer(s) for double-blind review. Articles are rejected or accepted based on the peer reviews and editorial board's decision.

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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

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

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- **Highlights**: authors must provide 3–5 highlights. This section must not exceed 400 characters, including spaces.
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- **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.
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- **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.
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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.
- Gams, I. 1994b: Changes of the Triglav glacier in the 1955-94 period in the light of climatic indicators. Geografski zbornik 34.
- Van Hall, R. L., Cammeraat, L. H., Keesstra, S. D., Zorn, M. 2016: Impact of secondary vegetation succession on soil quality in a humid Mediterranean landscape. Catena, In press. DOI: https://doi.org/10.1016/j.catena.2016.05.021 (25. 11. 2016).
- De Kerk, G. V., Manuel, A. R. 2008: a comprehensive index for a sustainable society: The SSI – The Sustainable Society Index. Ecological Economics 66-2,3. DOI: https://doi.org/10.1016/j.ecolecon.2008.01.029
- Perko, D. 1998: The regionalization of Slovenia. Geografski zbornik 38.
- Urry, J. 2004: The 'system' of automobility. Theory, Culture and Society 21-4,5. DOI: https://doi.org/10.1177%2F0263276404046059
- Yang, D. H., Goerge, R., Mullner, R. 2006: Comparing GIS-based methods of measuring spatial accessibility to health services. Journal of Medical Systems 30-1. DOI: https://doi.org/10.1007/s10916-006-7400-5

5.2 Citing books

- Cohen, J. 1988: Statistical power analysis for the behavioral sciences. New York.
- Fridl, J., Kladnik, D., Perko, D., Orožen Adamič, M. (eds.) 1998: Geografski atlas Slovenije. Ljubljana.
- Hall, T., Barrett, H. 2018: Urban geography. London. DOI: https://doi.org/10.4324/9781315652597
- Hall, C. M., Page, S. J. 2014: The geography of tourism and recreation: Environment, place and space. New York. DOI: https://doi.org/10.4324/9780203796092
- 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.
- Šifrer, M. 1997: Površje v Sloveniji. Elaborat, Geografski inštitut Antona Melika ZRC SAZU. Ljubljana.
- 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.

When the data you cited were published as a report, add it to the reference list and use the following format:

- 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.

To make anonymous peer review possible, include the name of the author(s) with the title of the illustration in the supplementary file metadata, but not in the article text.

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).

For maps made with ArcGIS with raster layers used next to vector layers (e.g., .tif of relief, airborne or satellite image), three files should be submitted: the first with a vector image without transparency together

with a legend and colophon (export in .ai format), the second with a raster background (export in .tif format), and the third with all of the content (vector and raster elements) together showing the final version of the map (export in .jpg format).

Do not print titles on maps; they should appear in a caption.

Save colors in CMYK, not in RGB or other formats.

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
© 2005, ZRC SAZU Anton Melik Geographical Institute

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*.

SUBMISSION PREPARATION CHECKLIST

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.

- I, the corresponding author, declare that this manuscript is original, and is therefore based on original research, done exclusively by the authors. All information and data used in the manuscript were prepared by the authors or the authors have properly acknowledged other sources of ideas, materials, methods, and results.
- Authors confirm that they are the authors of the submitting article, which is under consideration to be published (print and online) in the journal *Acta geographica Slovenica* by Založba ZRC, ZRC SAZU.
- All authors have seen and approved the article being submitted.
- The submission has not been previously published, nor it is under consideration in another journal (or an explanation has been provided in Comments to the Editor). Authors have disclosed any prior posting, publication or distribution of all or part of the manuscript to the Editor.
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- All the necessary permits to work with people have been obtained in the research related to the article (in accordance with the applicable laws and institutional guidelines and approved by the relevant institutions).
- The journal policies and guidelines have been reviewed and followed.

- The metadata (title, abstract, key words, authors, affiliation, ORCiD, etc.) are provided in English (Slovenian authors must provide the metadata also in Slovenian language).
- The list of authors is complete. Failure to do so may result in co-authors not being listed on the article at publication.
- The submission is in Microsoft Word format and the document template was used (single-spaced text, 12-point font, no formatting except italics and bold).
- The article has been checked for spelling and grammar.
- Figures are not embedded in the Word file and are provided as a supplementary file: editable vector format (e.g., cdr, ai) for maps and illustrations; tif for photographs; xlsx for graphs. The Word file includes only figure captions.
- 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:
Comments of the reviewer on the methods used in the article:

RECOMMENDATION OF THE REVIEWER TO THE EDITOR-IN-CHIEF

Please rate the article from 1 [low] to 100 [high] (this will NOT be presented to the author):
Personal notes of the reviewer to the editor-in-chief (this will NOT be presented to the authors):

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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.

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