МАКЕДОНСКО ГЕОГРАФСКО ДРУШТВО
MACEDONIAN GEOGRAPHICAL SOCIETY

ЗБОРНИК НА ТРУДОВИ

VI-ти КОНГРЕС НА МАКЕДОНСКИТЕ ГЕОГРАФИ
СО МЕЃУНАРОДНО УЧЕСТВО

PROCEEDINGS

VIth CONGRESS OF MACEDONIAN GEOGRAPHERS
WITH INTERNATIONAL PARTICIPATION

СКОПЈЕ / SKOPJE
29-30.V.2024

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ПРЕДГОВОР

Шестиот Конгрес на македонските географи, одржан во Охрид, креираше значајна улога во унапредувањето на географските истражувања во Македонија. Овој собир на еминентни научници и истражувачи од земјата и странство обезбеди платформа за размена на идеи, презентација на најсовремени истражувања и поттикнување на меѓународни соработки.

Овој Зборник го опфаќа разновидниот дијапазон на теми презентирани за време на Конгресот, одразувајќи ја динамичната и еволутивната природа на географските истражувања. Презентираните резултати нудат вредни сознанија за актуелни прашања како што се климатските промени, одржливоста на животната средина, просторното планирање, културното наследство и геополитичката динамика.

Упатуваме искрена благодарност до сите автори, рецензенти и членовите на организацискиот одбор за нивната посветеност и напорна работа при реализацијата на Конгресот, како и во процесот на публикување на овој Зборник. Веруваме дека ова издание ќе послужи како вреден ресурс за истражувачите, креаторите на политики и поширокатa академска заедница, инспирирајќи ги идните истражувања и придонесувајќи за подлабоко разбирање на сложените географски процеси кои го обликуваат нашиот свет.

Уредници

PREFACE

The VIth Congress of Macedonian Geographers, held in the enchanting city of Ohrid, marked a significant milestone in the advancement of geographical research in Macedonia. This gathering of esteemed experts and researchers provided a unique platform for the exchange of ideas, the presentation of cutting-edge research, and the fostering of international collaborations.

These Proceedings encapsulate the diverse range of topics explored during the Congress, reflecting the dynamic and evolving nature of geographical inquiry. The contributions presented herein offer valuable insights into pressing issues such as climate change, environmental sustainability, spatial planning, cultural heritage, and geopolitical dynamics.

We extend our sincere gratitude to all the authors, reviewers, and the organizing committee for their dedication and hard work in making this Congress and the subsequent publication of these Proceedings possible. We believe that this volume will serve as a valuable resource for researchers, policymakers, and the broader academic community, inspiring future research and contributing to a deeper understanding of the complex geographical processes shaping our world.

Editors

ПОЗДРАВНИ ГОВОРИ / WELCOME SPEECHES

VI-ти КОНГРЕС НА МАКЕДОНСКИТЕ ГЕОГРАФИ СО МЕЃУНАРОДНО УЧЕСТВО

ПРЕТСЕДАТЕЛ
Македонско Географско Друштво
д-р Христина Димеска Трајкова

Почитувани колеги, дами и господа,

Со големо задоволство Ве поздравувам на 6-от Конгрес на Македонските географи. Овој собир е сведоштво за нашата заедничка посветеност кон истражување, разбирање и зачувување на светот околу нас.

Како географи, имаме уникатна одговорност. Нашите истражувања, теренската работа и соработките ја откриваат комплексноста на нашата средина и ја поставуваат основата за одржлив развој и напредок. Географијата нуди перспектива преку која можеме да ги разбереме сложените интеракции помеѓу природата и општеството.

Овој Конгрес претставува драгоцена можност за размена на идеи, градење на соработка и развој на иновативни решенија за предизвиците со кои се соочува географијата. Нашите дискусии ќе опфатат широк спектар на теми, вклучувајќи физичка географија, картографија, ГИС и просторно планирање, социо-економска географија и настава во географијата.

Целта на овој Конгрес е да обезбеди платформа за дијалог, претставување на нови истражувања и размена на искуства. Нека нашите дискусии бидат плодни, нашите односи трајни, а нашите придонеси значајни. Во духот на соработката, ве охрабрувам сите вас да се вклучите отворено, да ги споделите вашите знаења и да се предизвикате еден со друг да размислувате критички и креативно.

За време на овие денови на интензивно разменување на искуства и поврзување, да имаме предвид дека како географи, нашата улога оди подалеку од овој Конгрес. Таа се пренесува во училниците каде што ги едуцираме идните генерации, во заедниците каде што го применуваме нашето знаење и во политиките кои го обликуваат нашето општество.

Основано на 29 ноември 1949 година на Филозофскиот факултет во Скопје, Македонското географско друштво е посветено на развојот на географската наука и образование. Од тогаш, на доброволна основа, и во насока на поставените цели при неговото основање, Друштвото континуирано работи на развој и напредок на географската наука и наставата во образовниот систем на земјата.

Целите на друштвото вклучуваат ширење на географското знаење, организирање и поддршка на истражувања, подобрување на наставата по географија и одржување на врски со слични друштва и институции низ светот. Друштвото организира конгреси, симпозиуми и го издава списанието „Географски разгледи“. Дополнително, организира семинари за наставници и натпревари за ученици во средно образование. Овие активности се спроведуваат во соработка со Институтот за географија при Природно-математичкиот факултет во Скопје.

Сакам да ја изразам мојата благодарност до Организациониот одбор за нивната напорна работа во реализацијата на овој Конгрес. Исто така, изразувам благодарност до Раководителот на Институтот за географија, професор Благоја Маркоски, и до членовите на Инстиутот. Во продолжение, искажувам благодарност до Природно-математичкиот факултет и Деканот на факултетот, професор Даворин Трпески, за поддршката во реализацијата на Конгресот, но и континуираната поддршка на Македонското географско друштво.

Се надевам дека вашиот престој во вековитиот Охрид, опкружен со сините води на Охридското езеро ќе биде пријатен, ви посакувам успешни презентации и плодни дискусии за време на Конгресот. Важноста на меѓународната соработка за напредокот на географската наука е нагласена на овој настан на кој се презентираат над 50 научни трудови од седниве држави: Албанија, Босна и Херцеговина, Хрватска, Косово, Северна Македонија, Полска и Србија.

Како Претседател на Македонското географско друштво, со големо задоволство и чест го организирам овој настан. Одржувањето на научни настани како овој Конгрес го збогатува нашето разбирање и значително придонесува за напредокот на географската наука.

Ви благодарам за вниманието и нека овој Конгрес биде значаен настан за сите.

VIth CONGRESS OF MACEDONIAN GEOGRAPHERS WITH INTERNATIONAL PARTICIPATION

PRESIDENT
Macedonian Geographical Society
Hristina Dimeska Trajkova, PhD

Distinguished colleagues, ladies and gentlemen,

It is a great pleasure that I welcome you to the 6th Congress of Macedonian Geographers. This gathering serves as a testament to our shared commitment to exploring, understanding, and preserving our world.

As geographers, we hold a unique responsibility. Our research, fieldwork, and collaborations uncover the complexities of our environment and set the stage for sustainable development and progress. Geography offers a perspective through which we can understand the complexities of the interactions between nature and society.

This Congress presents a valuable opportunity to exchange ideas, build collaborations, and develop innovative solutions to the challenges facing the geography.

Our discussions will cover a wide range of topics, covering physical geography, cartography, GIS & spatial planning, socio-economic geography, teaching, and education in geography.

The objective of this Congress is to provide a platform for dialogue, the presentation of new findings, and the exchange of inspiration. May our discussions be beneficial, our relationships last, and our contributions make an impact. In the spirit of collaboration, I encourage each of you to engage openly, share your knowledge, and challenge each other to think critically and creatively.

During these days of intense learning and networking, let us keep in mind that as geographers, we go beyond this Congress. It reaches into the classrooms where we educate future generations, the communities where we apply our knowledge and the policies that shape our societies.

Founded on November 29, 1949, at the Faculty of Philosophy in Skopje, the Macedonian Geographical Society has been dedicated to the development of geographical science and education.

Since then, on a volunteer basis, and in the direction of the set goals during its establishment, the Organization has continuously worked on the development and advancement of geographic science and teaching within the country's education system.

The society's goals include spreading geographical knowledge, organizing and supporting research, improving geography teaching, and maintaining connections with similar societies

and institutions worldwide. The Society organizes congresses, symposiums, and publishes the journal "Geographical Review". Additionally, it organizes seminars for teachers and competitions for students in education. These activities are carried out in cooperation with the Institute of Geography at the Faculty of Natural Sciences and Mathematics in Skopje.

I want to express my gratitude to the Organizing Committee for their hard work in making this Congress possible. I also want to express my gratitude to the Head of the Institute of Geography, Professor Blagoja Markoski, and its members, and I express my gratitude to the Faculty of Natural Science and Mathematics, and Dean of the Faculty, Professor Davorin Trpeski, for the support of the Congress and their ongoing support of the Macedonian Geographical Society.

I hope that your stay in the ancient city of Ohrid, surrounded by the blue waters of Ohrid Lake, will be pleasant, I wish you successful presentations, and fruitful discussions during the Congress. The importance of international collaboration in advancing geographical science is highlighted in this event that showcases over 50 scientific papers from representatives of Albania, Bosnia & Herzegovina, Croatia, Kosovo, North Macedonia, Poland and Serbia. As the President of the Macedonian Geographical Society, I am delighted and honored to host this event. The holding of scientific events like this Congress enriches our understanding and contributes significantly to the advancement of geographical science.

Thank you for your attention, and may this Congress be a memorable and impactful event for all.

Проф. д-р Благоја Маркоски
Универзитет „Св. Кирил и Методиј“ Скопје
Природно математички факултет, Скопје
Институт за географија

Почитувани колешки и колеги географи,
Почитувани гости пријатели на географијата

Институтот за географија при Природно математичкиот факултет во Скопје скоро 80 години е носител на географското образование и наука во Македонија. Дипломираните кадри на Институтот го формираат Македонското географско друштво. И така Институтот за географија и Македонското географско друштво генерално функционираат заедно. До сега се одржани поголем број научни собири на географите од Македонија и од странство. Во тој контекст е и овој настан именуван како Шести конгрес на Македонските географи со маѓународно учество.

Географијата како наука ги реализира фазите на дескрипција, фактографија и апликативност. Примената на современата географија особено е насочена кон изработка на: регионално и просторно планска документација, организација и воспоставување на Географски информациски системи за разни области од природните и социо-економските карактеристики и ред други аспекти.

На Шестиот конгрес на македонските географи со меѓународно учество имаме учесници од повеќе држави (Босна и Херцеговина, Македонија, Полска, Србија и Хрватска). Учесниците ќе имаат можност да разменат искуства во врска со развојот и статусот на географијата во нивните општества. Така ќе имаме подобар увид во кој правец треба да се развива географската наука и образование во иднина.

Почитувани географи, во име на членовите на Институтот за географија при Природно математичкиот факултет во Скопје и во мое лично име ви посакувам плодна и успешна работа на Конгресот.

Посебен поздрав за плодна и успешна работа на Шестиот конгрес на македонските географи со меѓународно учество ви пренесувам и од името на деканот на Природно математичкиот факултет во Скопје проф. д-р Даворин Трпески.

На сите ви посакувам пријатен престој во Охрид и Македонија.

Благодарам за вниманието.

Prof. Dr. Blagoja Markoski
University "St. Cyril and Methodius" Skopje
Faculty of Natural Mathematics, Skopje
Institute of Geography

Dear geographers,
Dear guests, dear colleagues

The Institute of Geography at the Faculty of Natural Sciences and Mathematics in Skopje has been the cornerstone of geographical education and research in Macedonia for nearly 80 years. Its graduates contribute to the Macedonian Geographical Society, with the Institute and the Society typically collaborating closely. Over the years, numerous scholarly gatherings, both domestic and international, have been organized. In this tradition, the upcoming event is titled the Sixth Congress of Macedonian Geographers with international participation.

Geography, as a discipline, progresses through stages of description, factography, and applicability. Modern geography focuses particularly on the development of regional and spatial planning documents, the establishment of Geographical Information Systems for various natural and socio-economic domains, and other related fields.

The Sixth Congress of Macedonian Geographers with international participation hosts delegates from several countries, including Bosnia and Herzegovina, Macedonia, Poland, Serbia, and Croatia. Participants will have the opportunity to exchange experiences regarding the advancement and status of geography within their respective societies, thereby gaining insights into the future development of geographical science and education.

On behalf of the members of the Institute of Geography at the Faculty of Natural Sciences and Mathematics in Skopje, as well as I personally, extend my best wishes for a productive and successful Congress.

In addition, on behalf of the Dean of the Faculty of Natural Sciences and Mathematics in Skopje, Prof. Dr. Davorin Trpeski, I extend a warm welcome to all participants.

We hope you enjoy your time in Ohrid and throughout Macedonia.

Thank you for your attention.

ЗАКЛУЧОЦИ
ОД ШЕСТИОТ КОНГРЕС НА МАКЕДОНСКИТЕ ГЕОГРАФИ СО МЕЃУНАРОДНО УЧЕСТВО

Шестиот конгрес на македонските географи со меѓународно учество се одржа во деновите од 29-30. 5. 2024 г. во Охрид. На конгресот беа донесени следните заклучоци:

1. Зајакнување на регионалната соработка на полето на географијата, во функција на понапредна образовна и научна комуникација и размена на стручни информации поврзани со географската наука и политиките на географското образование.

2. Учесниците на Конгресот инсистираат на немешање на политиката во географската наука и образование, со цел попрофесионална реализација на географското образование во образовниот систем на државата, како фундамент од национално и интернационално културолошко значење.

3. Почитување на стандардните методологии на научно истражувачката работа во географијата, како и примена на современите методи и техники во функција на осовременување на географските истражувања и проучувања.

4. Учесниците на Конгресот потенцираа потреба од перманентно одржување и зајакнување на кадровскиот потенцијал во основното, средното и високото образование.

5. Да се инсистира на поголемо стручно ангажирање на наставниот кадар во образовниот систем поврзан со географското образование и наука.

6. Надлежните институции да преземат мерки за заштита на наставниот кадар во дејноста на образованието, така што во функција на поквалитетно образование покрај дефинирањето на правата на учениците/родителите да се дефинираат и правата на наставниците.

7. Учесниците на Конгресот констатираа, дека е неминовно воспоставување на финансиска поддршка во географската наука и образование во функција на зајакнување на националните потреби во полето на географијата.

8. Типично географските проблеми мора да бидат предмет на проучување на географите со цел пристапот да биде високопрофесионален, а не парцијален како што си дозволуваат поединци од други струки да обработуваат географски теми. Географите во тој домен мора да имаат строг критички осврт.

9. Предмет на географијата е географскиот простор, токму затоа географијата во образовниот систем мора да го добие предзнакот национална дисциплина.

10. Учесниците на Конгресот констатираа дека има потреба од организација на наменски собир во функција на организацијата на географското образование во основните и средните училишта и развојот на методика на наставата по географија.

Организационен одбор на Шестиот конгрес на
македонските географи со меѓународно учество

CONCLUSIONS
FROM THE SIXTH CONGRESS OF MACEDONIAN GEOGRAPHERS WITH INTERNATIONAL PARTICIPATION

The sixth congress of Macedonian geographers with international participation was held on days 28-30. 5. 2024 in Ohrid. The following conclusions were reached at the congress:

1. Strengthening regional cooperation in the field of geography, as a function of more advanced educational and scientific communication and exchange of expert information related to geographic science and the policies of geographic education.

2. The participants of the Congress insist on the non-interference of politics in geographical science and education, with the aim of more professional realization of geographical education in the educational system of the state, as a foundation of national and international cultural significance.

3. Respect for the standard methodologies of scientific research work in geography, as well as the application of modern methods and techniques in order to modernize geographical research and studies.

4. The participants of the Congress emphasized the need for permanent maintenance and strengthening of personnel potential in primary, secondary and higher education.

5. To insist on greater professional engagement of teaching staff in the educational system related to geographic education and science.

6. Competent institutions should take measures for the protection of teaching staff in the activity of education, so that in the function of higher quality education, in addition to defining the rights of students/parents, the rights of teachers should also be defined.

7. The participants of the Congress concluded that it is inevitable to establish financial support in geographical science and education in order to strengthen the national needs in the field of geography.

8. Typically, geographical problems must be the subject of study by geographers in order for the approach to be highly professional and not partial as individuals from other professions allow themselves to treat geographical topics. Geographers in that domain must have a strict critical review.

9. The subject of geography is the geographical space, that is why geography in the educational system must receive the sign of a national discipline.

10. The participants of the Congress concluded that there is a need for the organization of a dedicated gathering in function of the organization of geographic education in primary and secondary schools and the development of geography teaching methodology.

Organizing Committee of the Sixth Congress of
Macedonian geographers with international participation

SECTION PHYSICAL GEOGRAPHY

TREND ANALYSIS OF TEMPERATURE, PRECIPITATION AND RIVER DISCHARGE IN THE RASINA RIVER BASIN, SERBIA

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ABSTRACT

In this research, changes in air temperature, precipitation and discharge were analyzed on the territory of the Rasina River basin (central Serbia). Monthly and annual temperature and discharge means, as well as monthly and annual sums of precipitation for all the stations in the period of 60 years (1961–2020), were provided by the Republic Hydrometeorological Service of Serbia. The change detection analysis has been conceded using Pettitt's test, while the linear regression, Mann-Kendall, and Sen's slope tests have been applied for trend analysis. The analysis indicated that the average annual, winter, spring and summer temperatures show a significant increasing trend both in the longer period (1961–2020) and in the second part of the period (1991–2020). In the first part of the period (1961–1990), annual and autumn temperatures in Kruševac, showed a significant decreasing trend. The seasonal precipitation increased for all seasons, as well as temperatures, except for spring in the first period (1961–1990) and autumn in the second period (1991–2020) in both stations. Obtained results of mean annual and mean seasonal discharge trends are generally not statistically significant. The exceptions are winter discharges in Bivolje in the period 1961–2020 and mean discharges in Brus (1961–1990), where a moderate significance decrease is recorded. The discharge is lower in the second half-period for all seasons. The Pettitt test determined that there was a change point detection in the data. For the year 1981, it was established that there was a significant decrease in annual discharge on the Rasina River in Brus, from 2.82 m^3/s to 2.21 m^3/s; in 1983 there was a significant increase in annual temperature in Kopaonik, from 2.62°C to 4.69°C. 1998 also showed an increase in temperature in Kruševac, from 10.86°C to 12.4 °C.

Keywords: temperature, precipitation, discharge, statistical homogeneity test, Mann-Kendall test, Rasina River

INTRODUCTION

Trend changes in climate are the most important topic in climatic research of the last few decades and are still one of the main challenges nowadays (Arora et al., 2005). Climate change and human activities are two major drivers of hydrological regime modifications (Gnjato et al., 2019). Recent climate change has already affected the global hydrological cycle. These effects have manifested in changing the seasonal river flows and increasing the frequency of occurrence of floods and droughts (but also in their severity) in some regions. The major factor of climate change is the increasing temperature. According to the IPCC (2013) report, the average global surface temperature of the world has increased by 0.74 °C± 0.18 °C in the past 100 years. Available records show that the 1990s have been the warmest decade of the millennium in the Northern Hemisphere. The annual mean surface air temperature has increased significantly in

almost all parts of Serbia (Stričević et al., 2022). The rises in temperatures were higher in the northern than in the southern parts of Serbia, and the increase was the highest in spring (Malinović-Milićević et al., 2015). The regions with the greatest increase in temperature are Eastern Serbia and the region of Vojvodina (Radivojević et al., 2015; Gavrilov et al., 2015, 2016). Another important factor is the variability of precipitation. The precipitation in an area is an important factor in determining the amount of water available to meet various demands, such as agricultural, industrial, and domestic water supply, as well as the water used for hydroelectric power generation (Panda et al., 2019).

Milanović et al., (2015) found an increasing trend for the mean annual precipitation in most of the areas in Serbia. The results of Malinović-Milićević et al., (2015) showed that the amount and intensity of precipitation showed a statistically significant increase only during autumn, and this was most pronounced in the northern and western parts of the country. Over the past several decades, numerous studies all over the world have analyzed river discharge variability and its relations to recent climate change (Cherinet et al., 2019; Da Silva et al., 2015; Croitoru et al., 2015; Gnjato et al., 2019; Hu et al., 2019; Zaghloul et al., 2022). In Europe, river discharges decreased over the southern and eastern parts of the continent, whereas a positive trend was noticed for some rivers discharging into the North Sea and Eastern Atlantic (Gnjato et al., 2019). A significant negative trend in annual and seasonal discharges was detected in Serbia (in all seasons except autumn) (Kovačević-Majkić et al., 2014; Langović et al., 2017; Langović, 2019; Martić Bursać et al., 2022).

In the present study, statistical methods of trend detection and change point analysis have been used for annual and seasonal temperature, discharges and sum of the precipitations in the Rasina river basin, from 1961 to 2020. The objective of the research was to examine the homogeneity of the data during the period of observation, and to pinpoint the components of a trend in the analyzed data on annual and seasonal average data. The research results will not only provide evidence for climate change in the Rasina river basin but can also lay the foundation for further studies on water resources security evaluation in conditions of climate change.

MATERIALS AND METHODS

Study Area

The basin of the Rasina River is situated in the south part of the Central Serbia with a surface area of 979,6 km^2 (Stričević, 2015). The Rasina River emerges on the east and south-east slopes of the mountains of Goč, Željin and Crni vrh where its constituents the Velika river and the Burmanska river emerge (Filipović et al., 2017). If the Burmanska river is taken as the main source of the Rasina River, then its total length is 92.3 km. The Rasina is the biggest right tributary of the Zapadna Morava, which empties at the town of Kruševac at 134 m above sea level. The basin of the Rasina River is asymmetrical-the surface area of the left side of the watershed is 191.4 km^2 (19.5%), and right-788.2 km^2 (80.5%). The Rasina River has 96 tributaries – 37 left (10 constant and 27 periodical tributaries) and 59 right (35 constant and 24 periodical tributaries). Significant tributaries are:the Graševačka river (21.3 km), the Blatašnica river (14.5 km) and the Lomnička river (17 km) on the right, and Zagrža river (11,3 km) on the left (Stričević, 2015).

The climate of the Rasina River basin is highly determined by its geographical position and relief. The largest part of the Rasina river basin is situated in the zone of temperate continental climate with continental pluviometric regime, while mountainous climate is represented on the mountain edge of the basin. According to Kepen's classification, most of the basin belongs to the so-called C climate, i.e. moderately warm, with the exception of the mountainous area of Kopaonik, which belongs to the D climate - moderately cold climate (Stričević et al., 2022).

Maximum average monthly discharges in the Rasina River basin were recorded in April and March, as a result of the melting snow from the surrounding mountains and intensive spring precipitations, while minimum average discharges occurred at the end of summer and the beginning of autumn, as a consequence of lower precipitation amount in the warmer part of the year, as well as high summer air temperatures and evaporation.

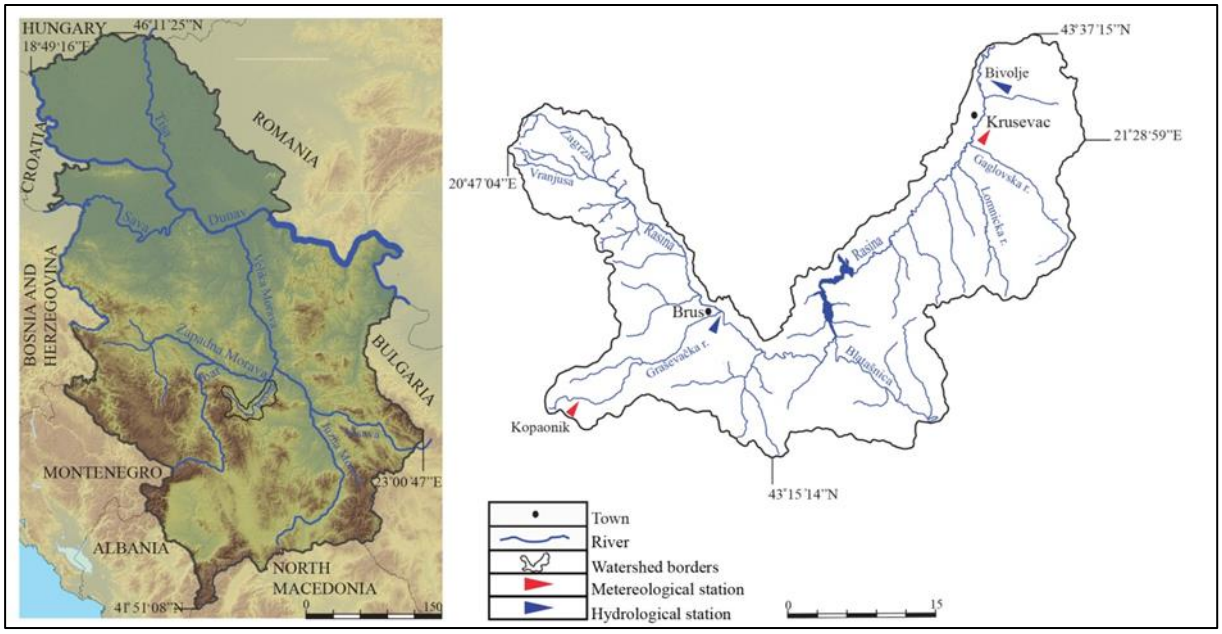

Figure 1. Geographical location of the research area and position of meteorological and hydrological stations in the Rasina River basin.

Data

Seasonal and annual climate data were examined, temperatures and precipitation in the towns of Brus and Kruševac, as well as discharge data from the two gauges on the Rasina river, Brus and Bivolje. Monthly and annual temperature and discharge means, as well as monthly and annual sums of precipitation for all the stations in the period of 60 years (1961–2020), were provided by the Republic Hydrometeorological Service of Serbia (RHMS). The locations of the stations are presented in Figure 1. Seasons were defined as follows: winter-W (December–February), spring-Sp (March–May), summer-Sm (June–August) and autumn-A (September–November). All the seasons correspond to the calendar year except for the winter season, which corresponds to January – February of the calendar year and to December of the previous year. As the time series was 60 years long, it was long enough to divide it into two equal 30-year-long periods, to find out if the series is homogenous, if it is a trend, and what the possible cause of

the changes is. The first half of the period occurred between 1961–1990, while the second occurred between 1991 and 2020.

Methodology

To determine the existence of a trend in annual and seasonal analyzed data, this paper used the non-parametric statistical method – Mann–Kendall test and Pettit's homogeneity test.

Pettit's test is a non-parametric test, which is useful for evaluating the occurrence of abrupt changes in climatic records. According to Pettit's test, if there is a change point in a series of n observed data, the distribution function of the first t samples F1 will be different from the distribution function of the second part of the series F2. The null hypothesis H0 implies that the data are homogeneous throughout the period of observation, and alternative hypothesis H1 implies the presence of a non–accidental component among data causes a shift of the location parameter at a particular moment. Aside from providing for a data homogeneity check, Pettit's test also determines if the alternative hypothesis happens to accept the change-point when a shift of the location parameter occurs (Pettit, 1979).

The statistical significance of the trend in annual and seasonal series was analysed using the non-parametric Mann-Kendall (MK) test (Mann, 1945; Kendall, 1975). The MK test checks the null hypothesis of no trend versus the alternative hypothesis of the existence of an increasing or decreasing trend (Kumar et. al., 2010). The positive values of Z (level of significance) indicate upward (increasing) trends in the time series, and the negative values show downward (decreasing) trends. Sen's slope estimator was used to compute the climate indices percentage of change over each year for the 60-year period (1961–2020). The value would indicate for instance how much on average it has modified each year either positively or negatively (indicating direction and size of trend) by overcoming the gross data time series errors and outliers if any (Doshi et al., 2023).

RESULTS AND DISUCCSION

In the present study, Pettitt's test has been applied to detect a change point in annual and seasonal series of temperature, precipitations and discharges in the Rasina river basin. For the used test, we failed to reject the null hypothesis when the estimated p-value was greater than the significance level of 0.05. After detecting the change point, the trend analysis was applied by using linear regression and the Mann-Kendall test. Trends are tested against some critical values to show whether they are statistically significant or not. In this study to represent the confidence level ***, **, * and + signs have been used to represent 100%, 99%, 95% and 90% levels of confidence respectively. The test statistics acceptance or rejection of the null hypothesis for annual and seasonal DATA has been presented in Table 1–6. Figs. 2–7 show annual and seasonal mean temperatures, precipitations and discharges, during the period 1961–2020 with three trend equations: above (1961–2020) and below (1961–1990 and 1991– 2020); and three trend lines: for longer and two shorter periods, respectively.

Temperature

The average annual and seasonal series in the period 1961-2020 on both stations indicated a significant change point, except on Kopaonik, where autumn data can be considered homogeneous. The test results indicate that the change in average annual temperature occurred in 1998 in Kruševac and 1983 on Kopaonik. The average annual temperature in the second period increased in Kruševac from 10.86ºC to 12.14 ºC and on Kopaonik it increased from 2.62ºC to 4.69 ºC. The average annual temperature for the period 1961–2020 is 11.4 °C in Kruševac and 3.9 °C on Kopaonik (Table 1).

Pettitt's test indicates the increase in average winter temperatures in Kruševac from 1991, while on Kopaonik the increase started in 1986. The analysis of spring temperature confirmed that the change point may have occurred in 1997 in Kruševac, while it may have occurred on Kopaonik in 1980. The change in average summer temperature occurred in 1990 in Kruševac and 1986 on Kopaonik. The average summer temperature in Kruševac increased from 20.06ºC to 21.82 ºC, and on Kopaonik it increased from 10.31ºC to 12.56 ºC.

Table 1. Pettitt's test statistic – Kruševac and Kopaonik-temperature (°C)

Period	Variable	Kruševac					Kopaonik				
		T_{av}	W	S_p	S_m	A	T_{av}	W	S_p	S_m	A
1961–2020	Mean (°C)	11.359	1.22	11.675	20.925	11.612	3.883	-4.653	1.992	11.624	4.729
	Kt	751	424	518	771	407	778	604	649	810	333
	tc	1998	1991	1997	1990	1997	1983	1986	1980	1986	2006
	p	0.0001	0.006	0.0002	0.0001	0.008	0.0001	0.0001	0.0001	0.0001	0.053
	T1	10.861	0.684	11.205	20.05	11.218	2.622	-5.58	0.505	10.292	4.729
	T2	12.139	1.856	12.464	21.831	12.324	4.689	-3.971	2.595	12.603	4.729
1961–1990	Mean (°C)	10.814	0.776	11.269	20.048	11.169	2.931	-5.314	1.107	10.497	4.321
	Kt	53	108	40	91	144	204	115	133	156	68
	tc	1967	1968	1964	1971	1968	1976	1976	1980	1974	1973
	p	0.75	0.068	0.943	0.170	0.004	0.0001	0.042	0.012	0.001	0.476
	T1	10.814	0.776	11.269	20.048	12.475	2.265	-5.813	0.505	9.815	4.321
	T2	10.814	-0.776	11.269	20.048	10.671	3.875	-4.779	2.250	11.050	4.321
1991–2020	Mean (°C)	11.945	1.745	12.131	21.831	12.048	4.859	-3.931	2.766	12.766	5.148
	Kt	156	126	115	112	128	165	86	120	136	130
	tc	2006	2006	1998	2005	2007	2006	2012	1998	2006	2008
	p	0.001	0.02	0.044	0.052	0.015	0.0003	0.221	0.028	0.008	0.015
	T1	11.520	1.22	11.086	21.831	11.612	4.407	-3.931	1.514	12.247	4.582
	T2	12.400	2.307	12.464	21.831	12.667	5.343	-3.931	3.164	13.321	5.950

In the first half of the period (1961-1990) the test indicated a significant change point in average autumn temperatures in Kruševac, and average annual, winter, summer and spring temperatures on Kopaonik. The average autumn temperature in Kruševac and winter temperature on Kopaonik have a decreasing trend, while average annual, spring and summer temperatures in Kopaonik have a statistically important increasing trend.

In the first period (1961-1990), the trend is negative for average annual, spring and summer temperatures on both stations. The MK test indicated a non-significant decrease in the trend of annual temperature in Kruševac and a significant increase in the trend of annual temperature on Kopaonik. In the second half of the period (1991–2020) the test in both stations detects 2006 as a changing point of average annual and summer temperatures, 1998 as a changing point of annual spring temperature, and 2007 and 2008 as a changing point of annual autumn temperature. The average annual and seasonal temperatures in this period show a positive trend

in both stations. The MK test indicated a significant increase in temperature during all the seasons in Kruševac, summer and autumn on Kopaonik, with very high certainty (α=0.005–0.0001).The annual temperature exhibits an increasing trend from 0.5ºC/decade in Kruševac and 0.7ºC/decade in Kopaonik. The trend pattern indicated a significant increase in average annual, winter and summer temperatures in the whole series from 1961 to 2020. The statistically significant increase is also detected in spring in Kruševac and Kopaonik. The annual temperature for the Rasina river basin exhibits an increasing trend of annual temperature from 0.2ºC/decade in Kruševac and 0.7ºC/decade on Kopaonik.

Table 2. Man – Kendall test's statistic – Kruševac and Kopaonik temperature

Period		Kruševac							Kopaonik						
		Min.	Max.	Mean	St.dev.	Z	S	α	Min.	Max.	Mean	St.dev.	Z	S	α
1961–2020	T_{av}	10.0	13.20	11.36	0.81	5.46	0.03	***	1.4	5.9	3.9	1.27	-1.03	0.07	***
	W	-2.3	4.1	1.22	1.40	3.48	0.037	***	-6.9	-0.7	-4.7	1.38	4.61	0.05	***
	S_p	8.8	14.0	11.67	1.17	3.19	0.03	**	-1.1	5.6	1.9	1.48	5.30	0.06	***
	S_m	18.3	24.4	20.93	1.25	5.28	0.044	***	8.4	15.6	11.6	1.49	7.15	0.07	***
	A	8.5	14.7	11.61	1.24	2.35	0.023	*	0.8	7.8	4.7	1.44	2.25	0.02	*
1961–1990	T_{av}	10.0	11.6	10.81	0.43	-0.19	0.0	-	1.4	4.6	2.9	0.95	3.52	0.09	***
	W	-2.3	2.9	0.78	1.31	1.30	0.047	-	-6.9	-3.0	-5.3	1.13	2.76	0.08	**
	S_p	8.8	13.7	11.3	1.17	0.23	0.005	-	-1.1	4.0	1.1	1.34	2.10	0.06	*
	S_m	18.3	22.0	20.05	0.74	-1.13	-0.02	-	8.4	12.9	10.5	0.98	2.92	0.06	**
	A	8.5	13.1	11.17	1.27	-2.31	-0.07	*	0.8	6.3	4.3	1.57	-0.17	0	-
1991–2020	T_{av}	10.7	13.2	11.94	0.69	3.01	0.05	**	3.3	5.9	4.9	0.69	2.35	0.06	***
	W	-1.4	4.1	1.74	1.30	2.26	0.06	*	-6.5	-0.7	-3.9	0.02	0.77	0.02	-
	S_p	9.7	14.0	12.13	0.99	1.86	0.047	+	-0.1	5.6	2.8	1.13	2.35	0.06	*
	S_m	20.3	24.4	21.83	1.02	1.77	0.033	+	11.2	15.6	12.8	0.99	2.16	0.04	*
	A	10.0	14.7	12.05	1.09	2.86	0.060	**	2.8	7.8	5.1	1.22	2.69	0.09	**

Z–value of trend; S–Sen's slope; α – level of significance *** - α=0.001 ; ** - α=0.01; * - α=0.05; + - α=0.1

According to the used data the hottest year on the territory of the Rasina basin was 2000, while out of 10 hottest years, 9 have occurred since the year 2000. The hottest summer was during 2012, the same as on the territory of the whole Serbia (Vuković et al., 2018). The mean annual temperature for the period of 1991–2020 increased by 1.3°C with respect to the period of 1961–1989. The highest increase of 1.5°C, is recorded for the summer season. The season with the second highest increase in temperatures is spring.

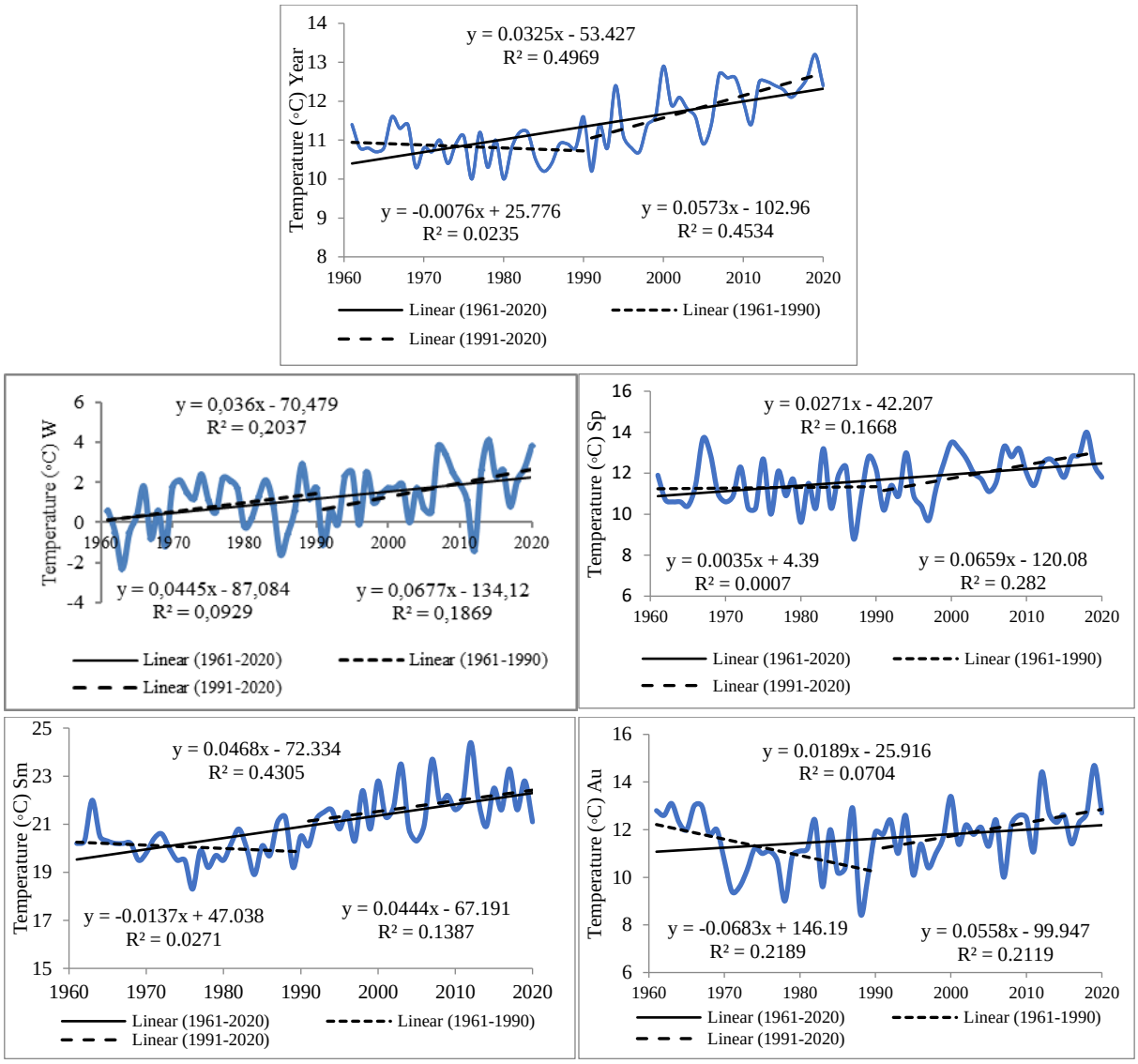

Figure 2. Average annual and seasonal temperatures, trend equations, and trend lines for Kruševac

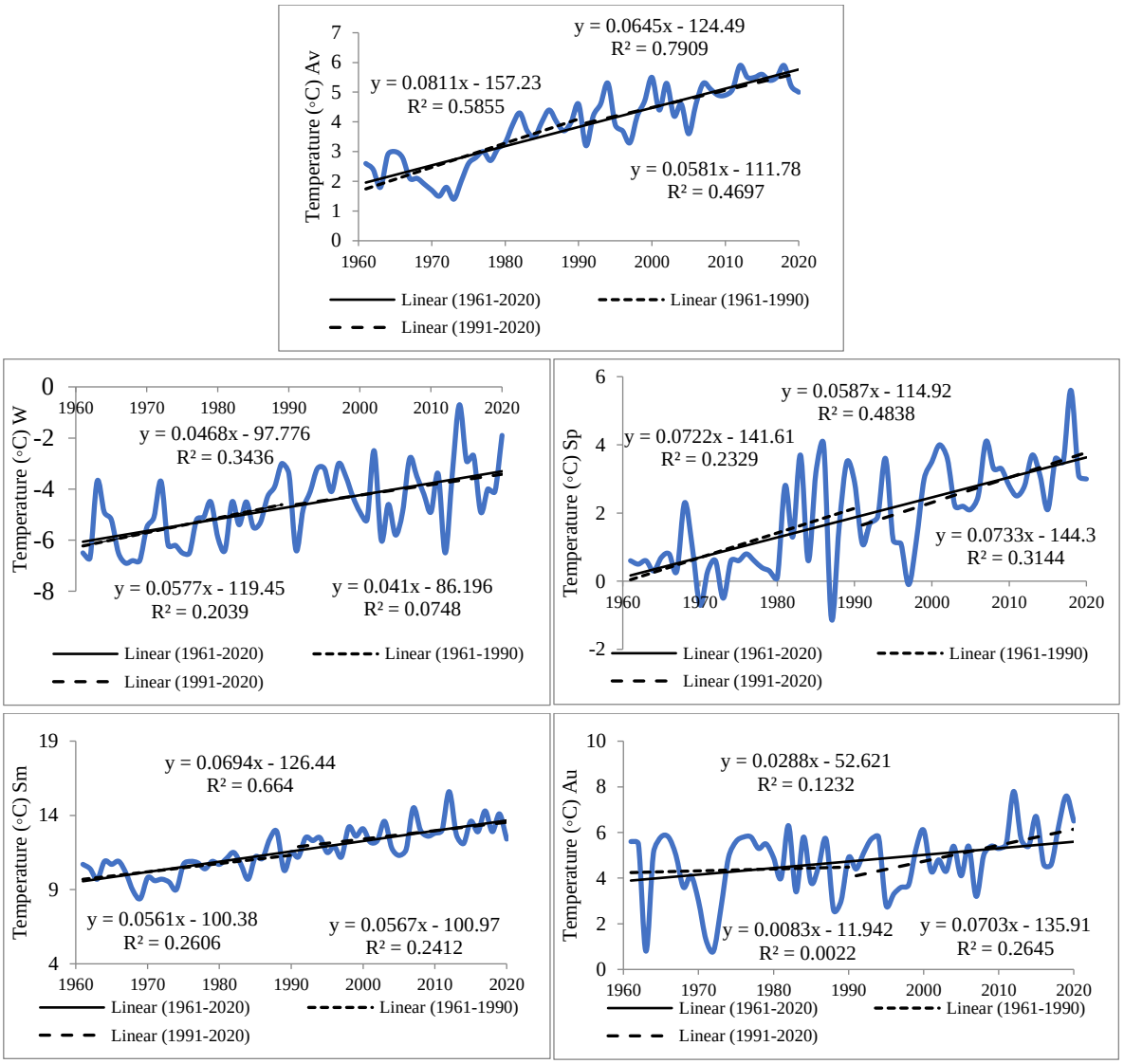

Figure 3. Average annual and seasonal temperatures, trend equations, and trend lines for Kopaonik.

Precipitation

In the period 1961–2020 a significant change point is observed on Kopaonik in annual winter and autumn precipitation. A change point in average annual precipitation was not detected. Average precipitations for the entire period are 651.1 mm in Kruševac and 999.9 mm in Kopaonik (Table 3). In the second period the average annual precipitation decreased for 2.1% in Kruševac, while in Kopaonik an increase of precipitation from 8.6% is detected.

The Mann-Kendal test reveals that the linear trend of total annual precipitation in the entire period is increasing and statistically significant on Kopaonik. In the first half of the period (1961–1990) Pettitt's test indicated a significant change point in average winter, summer and autumn precipitation on Kopaonik. In Kruševac the trend of average annual precipitation is increasing without statistical significance, while in Kopaonik it is decreasing, with statistical significance α=0.001. In the second period, a change point was not detected at any station. The linear trend of precipitation in the second period is positive and statistically significant at both stations (α=0.05).

Table 3. Pettitt's test statistic – Kruševac and Kopaonik- precipitation (mm)

Period	Variable	Kruševac					Kopaonik				
		T_{av}	W	S_p	S_m	A	T_{av}	W	S_p	S_m	A
1961–2020	Sum (mm)	657.1	139.5	180.2	188.8	148.6	999.9	195	287.5	296.5	216.3
	Kt	257	267	296	162	173	328	368	246	296	399
	tc	2002	2002	2003	1978	1969	1993	2002	2007	1969	1973
	p	0.218	0.188	0.112	0.744	0.67	0.06	0.024	0.268	0.111	0.014
	T1	657.1	139.5	180.2	188.8	148.6	999.9	178.5	287.5	296.5	154.3
	T2	657.1	139.5	180.2	188.8	148.6	999.9	235.6	-287.5	296.5	233.5
1961–1990	Sum (mm)	651.2	139.2	176.1	193.4	145.2	958.6	179.1	274.8	310.6	188
	Kt	82	52	52	74	79	62	124	110	128	112
	tc	1968	1969	1981	1964	1969	1967	1973	1966	1969	1972
	p	0.264	0.761	0.769	0.374	0.250	0.593	0.021	0.057	0.014	0.05
	T1	651.2	139.2	176.1	193.4	145.2	958.6	151.8	274.8	395.2	150.3
	T2	651.2	139.2	176.1	193.4	145.2	958.6	201.4	274.8	278.4	207.8
1991–2020	Sum (mm)	664.8	141.4	184.7	182.6	154.3	1040.2	212.8	298.9	281	361.3
	Kt	103	134	122	66	65	98	112	110	70	50
	tc	2002	2003	2010	2012	2017	2011	2002	2008	2014	2008
	p	0.092	0.009	0.024	0.5	0.593	0.115	0.051	0.054	0.43	0.80
	T1	664.8	113.9	159.1	182.6	154.3	1040.2	212.8	298.9	218.0	361.3
	T2	664.8	160.7	241.4	182.6	154.3	1040.2	212.8	298.9	281.0	361.3

Table 4. Man – Kendall test's statistic – Kruševac and Kopaonik precipitation (mm)

Period		Kruševac							Kopaonik						
		Min.	Max.	Mean	St.dev.	Z	S	α	Min.	Max.	Mean	St.dev.	Z	S	α
1961–2020	T_{av}	385.1	986.4	657.1	122.72	1.25	1.19	-	644.8	1444.8	999.9	155.22	2.09	2.50	*
	W	27.3	269.6	139.5	49.24	0.62	0.26	-	57.9	366.8	194.9	59.16	2.90	1.38	**
	S_p	69.3	378.9	180.2	64.54	1.05	0.56	-	89.9	536.5	287.5	75.61	1.36	0.88	-
	S_m	53.2	392.6	188.8	75.93	0.03	-0.02	-	113.8	533.9	296.5	98.64	-1.48	-1.1	-
	A	41.8	320.2	148.6	59.83	0.53	0.31	-	79.0	447.5	218.1	80.13	2.56	1.54	**
1961–1990	T_{av}	433.6	893.2	651.2	105.93	0.01	1.39	-	644.8	1178.3	958.6	131.30	-0.66	-1.65	***
	W	27.3	234.5	139.2	51.90	0.01	-0.62	-	57.9	265.2	179.1	53.04	0.01	2.83	*
	S_p	93.8	326.7	176.1	63.18	0.01	-1.06	-	89.9	409.1	274.8	73.53	0.01	-0.45	-
	S_m	88.5	322.8	193.4	68.85	0.01	0.45	-	140.3	508.4	310.6	97.28	0.01	-5.56	**
	A	47.8	264.9	142.6	55.84	0.01	1.16	-	79.0	344.3	187.9	62.99	0.01	2.08	-
1991–2020	T_{av}	385.1	986.4	664.8	140.6	2.03	6.42	*	736.9	1444.8	1040.2	170.86	0.01	2.21	*
	W	60.4	269.6	141.4	47.4	0.01	1.94	*	120.3	366.8	212.8	61.06	0.01	2.47	-
	S_p	69.3	378.9	184.3	66.65	0.01	1.11	*	193.1	535.5	298.9	78.07	0.01	2.67	+
	S_m	53.2	392.6	182.6	84.02	0.01	2.14	-	113.8	533.9	281.1	100.88	0.01	2.65	-
	A	41.8	320.2	156.1	64.24	0.01	-0.58	-	79.0	447.5	218.1	80.13	0.01	1.54	**

The winter season in Kruševac has a change point detected in 2003 in the second period. The average winter precipitations are slightly higher in the second period, with a significant linear trend. On Kopaonik the change point is detected in 2002, in the entire period, the linear trend is positive and statistically significant. In the spring season, both stations recorded an increasing trend in the entire period. In the second period, the change point was found in 2010 in Kruševac. The sum of precipitation increased from 159.1 mm to 241.4 mm. In the summer season there is a decrease in the mean value between the first and second period at both stations. The positive trend is detected in both periods in Kruševac and the second period on Kopaonik. There is a decrease in precipitation and a simultaneous increase in temperature at both stations in this period. The decrease in precipitation in this season is more pronounced on Kopaonik than in Kruševac. In the autumn season we found an increase in mean precipitation in the second period at both stations. On Kopaonik the change point is detected in 1973 during the entire period and the linear trend is positive with statistical significance α=0.01.

There is an increase in mean precipitation in the second period at both stations. There are no change points in any period, while the trend is slightly positive with statistical significance α=0.05 only on Kopaonik.

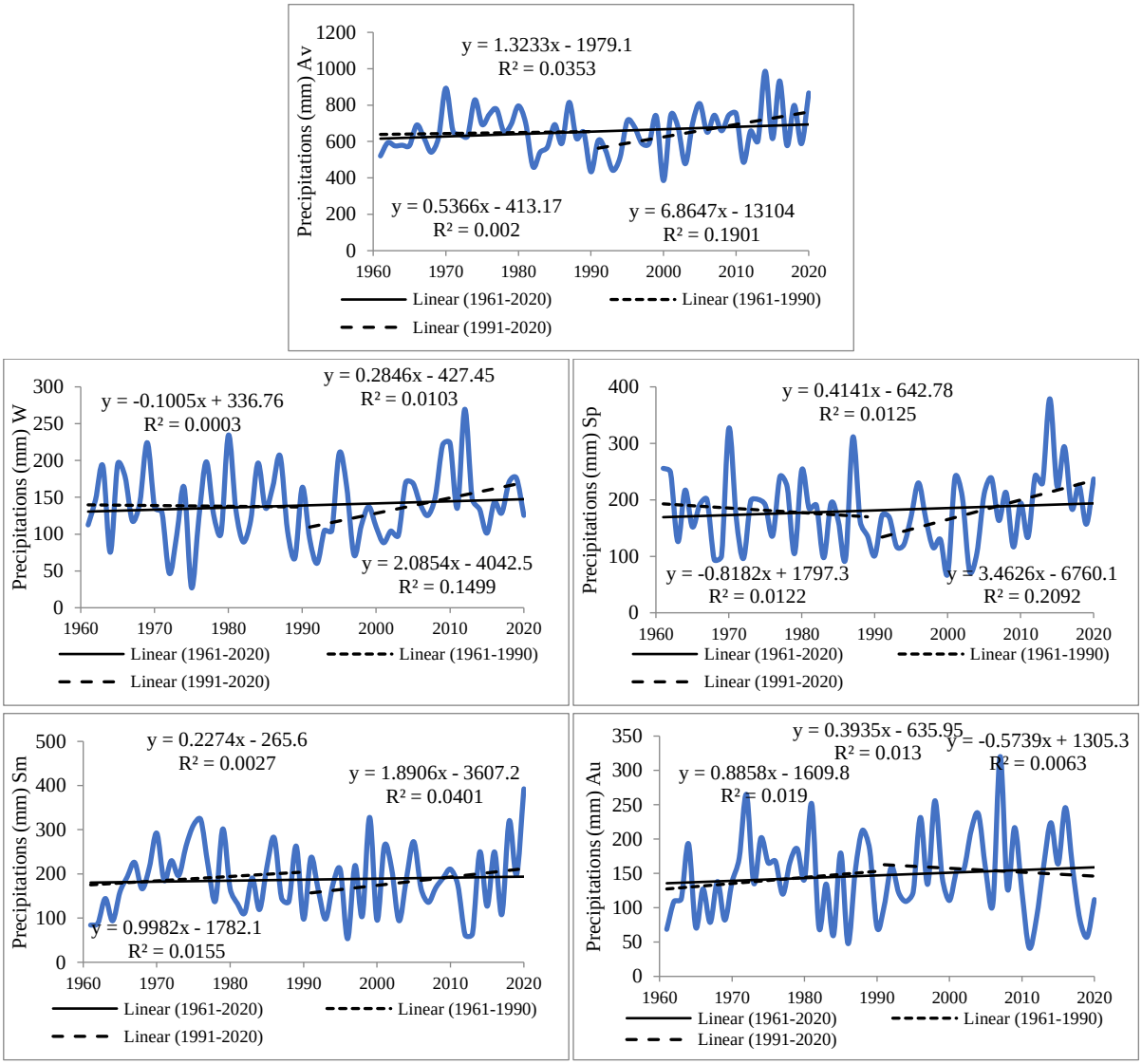

Figure 4. Average annual and seasonal precipitations, trend equations, and trend lines for Kruševac

According to the used data, the year with the highest sum of precipitation on the territory of the Rasina basin was 2014. The mean annual sum of precipitation for the period of 1991–2020 increased for 13.6 mm in Kruševac and for 81.6 mm in Kopaonik, with respect to the period of 1961–1990. The highest increase is recorded for the autumn season at both stations. The season with the second highest increase in precipitation is winter.

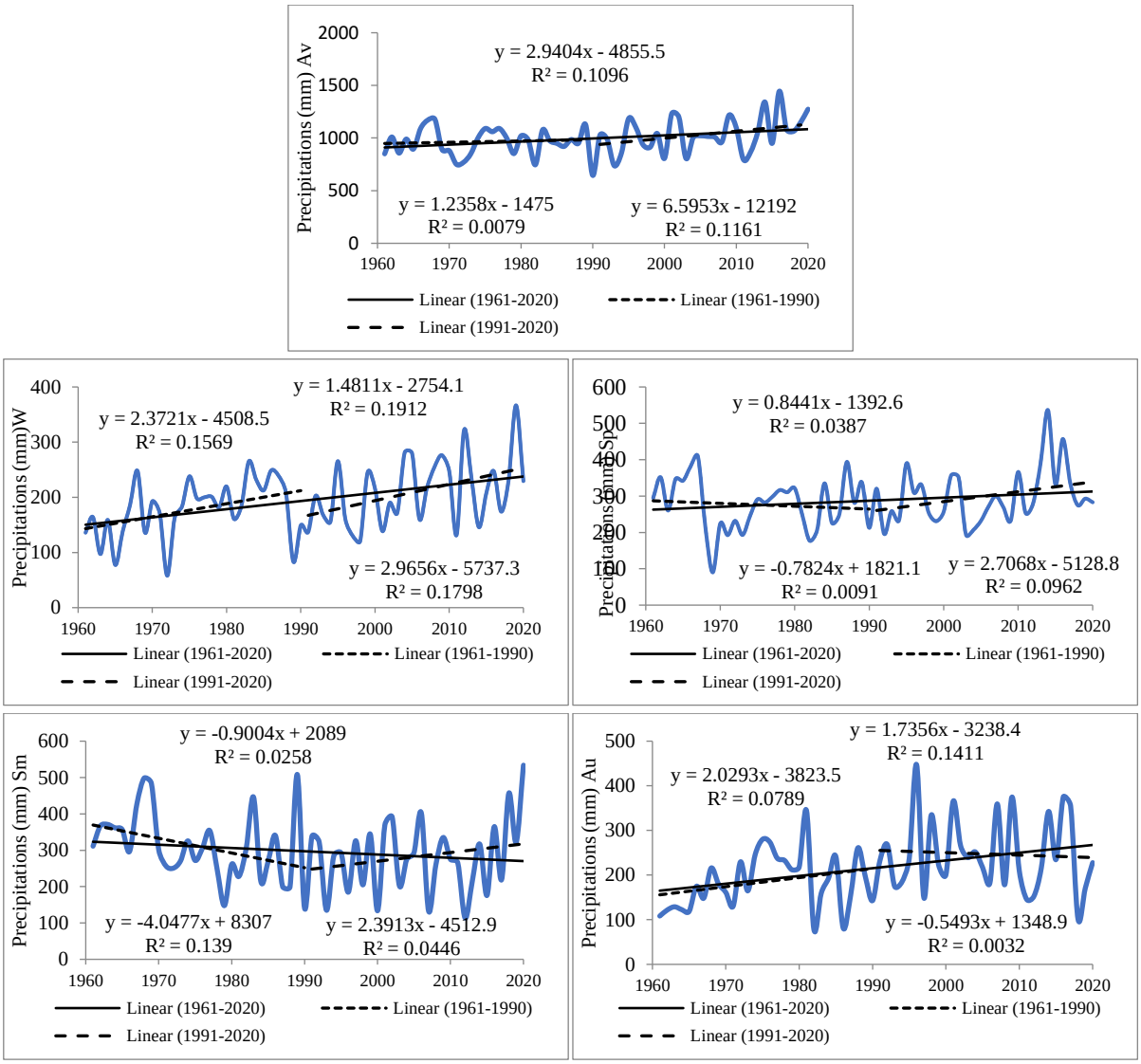

Figure 5. Average annual and seasonal precipitations, trend equations, and trend lines for Kopaonik.

Discharge

The average discharge of the Rasina in the entire period (1961–2020) in Brus is 2.41 m3/s and in Kruševac it is 7.36 m3/s, with a negative trend at both stations (Table 5). There is a change point in Brus in 1980, where the mean value of the discharge dropped from 2.82 m3/s to 2.21 m3/s. The mean value of the discharge is higher in the first period at both stations. In the second half of period there is a positive linear trend of increasing discharge without statistical significance. The analysis of trends of seasonal discharges at both stations showed that there were statistically significant changes in mean winter discharges in the whole period in Bivolje (α=0.05) and in average autumn discharges in the second period (α=0.1). In the winter season, there was a decrease in the mean annual discharge at both stations in the second period. In Brus, the average discharge was 10% lower in the second period, while precipitation was higher for 16%. The answer to this anomaly could be found in the period 1961–1990. In this period, there was a decrease in precipitation and an increase in temperature at Kopaonik stations. In the spring season, there is a trend of decreasing discharges in the entire period in the upper and in the lower course of the river, without statistical significance. In Bivolje, the average discharge

decreased by 4.5% in the second period, while at the same time, the increase in precipitation in Kopaonik was 8.1%. As there is also a positive trend of average temperature in Kopaonik, the most probable cause of additional discharge during this season comes from the late melting of snow accumulated during the winter season, primarily on Kopaonik. During the entire second period, there is a positive, statistically significant trend of increase in precipitation and temperature in Kruševac, which lead to a positive trend in the mean discharge in Bivolje. Even so, mean spring discharges in Bivolje dropped for 9.1% in the second period. The discharge trend throughout the summer season declined at both stations. The mean discharge in the second period is lower by 11.8% in Brus and 11.4% in Bivolje.

Table 5. Pettitt's test statistic – Brus and Bivolje- discharge (m^3/s)

Period	Variable	Brus					Bivolje				
		Q_{av}	W	S_p	S_m	A	T_{av}	W	S_p	S_m	A
1961–2020	Mean (m^3/s)	2.41	2.32	4.1	1.95	1.30	7.34	8.10	13.27	4.83	3.23
	Kt	409	316	204	280	268	315	447	185	199	226
	tc	1981	1980	1981	1979	1980	1981	1985	1981	1980	1980
	p	0.007	0.069	0.48	0.15	0.183	0.064	0.002	0.563	0.471	0.324
	T1	2.82	2.32	4.1	1.95	1.30	1.30	10.07	13.27	4.83	3.23
	T2	2.21	2.32	4.1	1.95	1.30	1.30	6.61	13.27	4.83	3.23
1961–1990	Mean (m^3/s)	2.53	2.49	4.20	2.04	1.38	7.79	9.38	13.24	5.07	3.44
	Kt	148	98	70	96	138	102	100	72	68	86
	tc	1981	1980	1970	1979	1980	1981	1980	1981	1977	1980
	p	0.002	0.119	0.437	0.131	0.007	0.096	0.107	0.408	0.468	0.220
	T1	2.82	2.49	4.20	2.04	1.69	7.79	9.38	13.24	5.07	3.44
	T2	1.88	2.49	4.20	2.04	0.70	7.79	9.38	13.24	5.07	3.44
1991–2020	Mean (m^3/s)	2.30	2.19	4.01	1.80	1.21	6.97	6.96	13.40	4.49	3.02
	Kt	68	72	58	70	76	90	65	89	67	66
	tc	2012	2009	2012	2016	2008	2002	1994	2003	2016	2006
	p	0.483	0.397	0.653	0.435	0.351	0.138	0.423	0.151	0.427	0.448
	T1	2.30	2.19	4.01	1.80	1.21	6.97	6.96	13.40	4.49	3.02
	T2	2.30	2.19	4.01	1.80	1.21	6.97	6.96	13.40	4.49	3.02

The discharge trend in the second period is positive at both stations. In the autumn seasons, the trend of decreasing discharge is most strongly expressed at both stations in the whole period and with statistically significant changes in the first period (1961–1990) in Brus. The decline in the mean discharge between the two observed periods is most pronounced in the winter season. In Brus, the discharge was 12.1 % lower in the second period, while in Bivolje it was lower by 25.8%. At the same time, we found that the average precipitation is higher by 1.8% in Kruševac and 8.1% in Kopaonik compared to the first period.

Table 6. Man – Kendall test's statistic – Brus and Bivolje-discharge (m^3/s)

Period															
		Min.	Max.	Mean	St.dev.	Z	S	α	Min.	Max.	Mean	St.dev.	Z	S	α
1961–2020	T_{av}	1.20	4.60	2.41	0.70	-1.49	-0.01	-	2.60	13.30	7.36	2.72	-0.94	-0.02	-
	W	0.95	4.46	2.32	0.81	-0.01	-0.01	-	1.82	19.33	8.10	4.05	-2.32	-0.07	*
	S_p	0.73	9.47	4.10	1.70	-0.56	-0.01	-	2.94	35.02	13.27	7.24	-0.16	-0.01	-
	S_m	0.40	4.58	1.94	1.11	-1.29	-0.01	-	1.26	14.19	4.83	2.93	-0.48	-0.01	-
	A	0.26	5.65	1.30	0.98	-1.10	-0.01	-	0.53	10.33	3.23	2.17	-0.94	-0.01	-
1961–1990	T_{av}	1.20	4.60	2.53	0.73	-2.51	-0.03	-	2.60	13.20	7.79	2.78	-1.58	-0.12	-
	W	1.38	4.46	2.49	0.89	0.01	-0.02	-	3.49	18.95	9.38	4.11	0.01	-0.12	-
	S_p	0.73	9.47	4.20	1.93	-0.01	-0.07	-	2.94	32.06	13.24	7.34	-0.01	-0.26	-
	S_m	0.62	4.55	2.04	1.03	-0.01	-0.03	-	1.33	14.19	5.07	3.03	0.01	-0.03	
	A	0.35	5.65	1.38	1.17	00.1	-0.02	+	0.65	10.33	3.44	2.46	-0.01	-0.02	
1991–2020	T_{av}	1.20	3.74	2.30	0.69	0.96	0.02	-	2.80	13.30	6.97	2.67	1.82	0.10	
	W	0.95	3.58	2.19	0.70	-0.01	-0.01	-	1.82	19.33	6.96	3.60	0.01	0.04	
	S_p	1.60	8.16	4.01	1.50	0.01	0.02	-	4.41	35.02	13.40	7.37	0.01	0.20	-
	S_m	0.40	4.58	1.80	1.20	0.01	0.02	-	1.26	14.16	4.49	2.86	0.01	0.07	-
	A	0.26	3.21	1.21	0.77	-0.01	-0.01	-	0.53	8.54	3.02	1.88	-0.01	-0.04	

Z–value of trend; S–Sen's slope; α – level of significance *** - α=0.001 ; ** - α=0.01; * - α=0.05; + - α=0.1

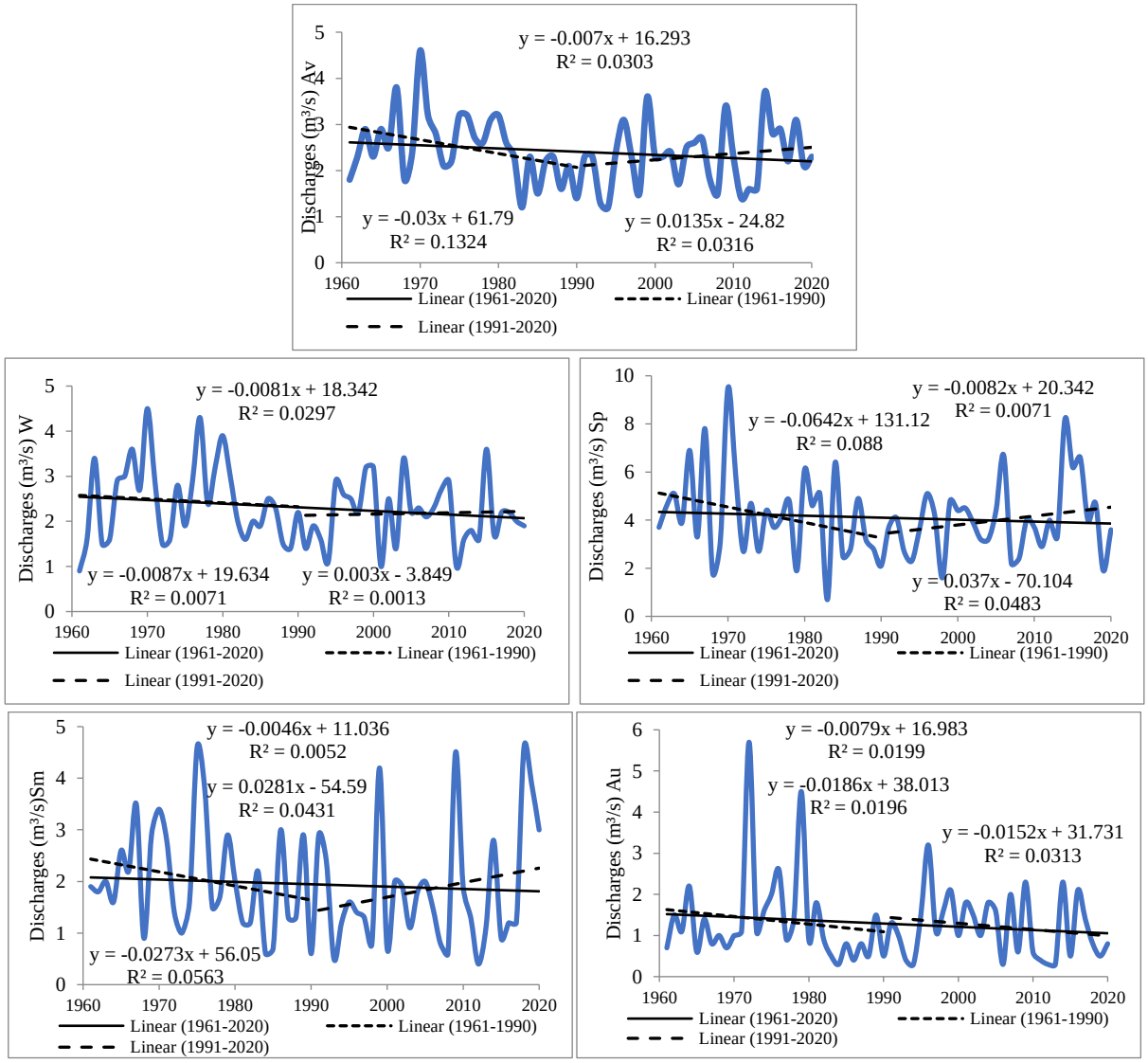

Figure 6. Average annual and seasonal discharge, trend equations, and trend lines for Brus

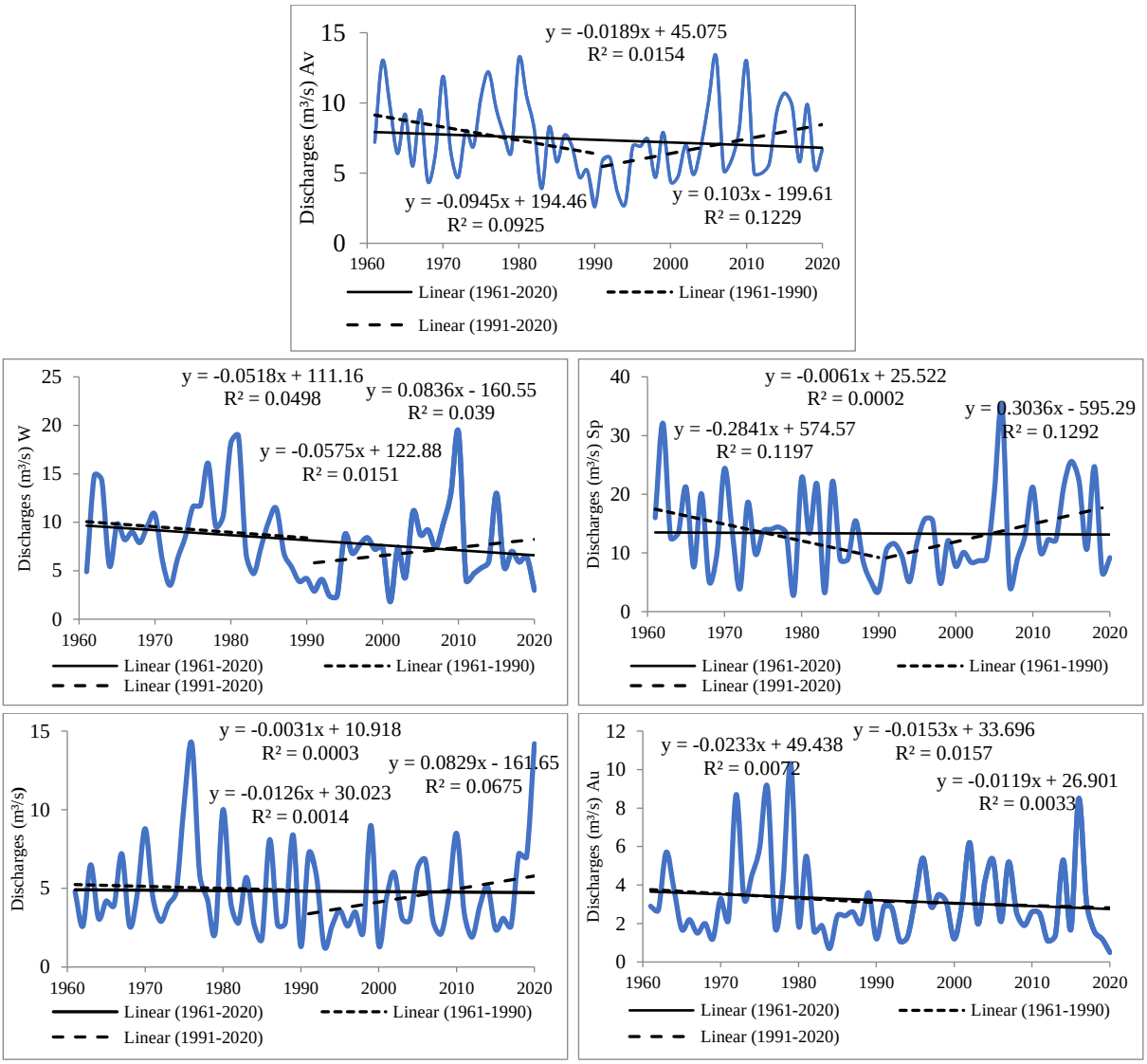

Figure 7. Average annual and seasonal discharge, trend equations, and trend lines for Bivolje

CONCLUSION

In this paper, long-term changes and trends in temperature, precipitation and discharges in the last 60 years in the Rasina River Basin were analyzed. Based on the statistical tests used, it can be concluded that there is a change point marking the occurrence of an increase in the average annual air temperatures in 1995 in Kruševac and 1984 on Kopaonik. The analysis indicated that the average annual, winter and summer temperatures, have significantly increasing trends in the longer period (1961–2020) and the second part of the period 1991–2020. In the period 1961–2020 a significant change point is observed on Kopaonik in annual winter and autumn precipitation. In Kruševac the trend of average annual precipitation is increasing, while in Kopaonik it is decreasing. In the second period, a change point was not detected at any station. Mean annual and seasonal average values of discharge at both stations are in all cases lower in the second period, except in the Sp season in Bivolje. In the W season, at both meteorological stations, there is an increase in the mean precipitation and temperature in the second analyzed period and a simultaneous decrease in discharge. The discharge trend throughout the summer season declined at both stations. In the spring season, there is a trend of decreasing discharges

in the entire period in the upper and the lower course of the river, without statistical significance. In the autumn seasons, the trend of decreasing discharge is most strongly expressed at both stations in the whole period and with statistically significant changes in the first period (1961–1990) in Brus. The river discharge regime in the Rasina River basin is strongly dictated by climate variability. Along the climatic factors, the use of water has also influenced the dominant decreasing trends in discharge values, especially because of the water supply of the settlements of the Kopaonik region (Paljevštica system) in the upper part of the basin and "Ćelije" system for water supply in the middle part of the river basin.

This study provides detailed information of trends in hydroclimatic variables in the Rasina River basin during recent decades, which is useful for future regional and local planning and integrated utilization of water resources.

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SECTION CARTOGRAPHY, GIS AND REGIONAL GEOGRAPHY

INTEGRATED APPROACH IN GEOTECHNICAL RISK ANALYSES FOR BRZA VODA WATERSHED IN POLOG REGION

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ABSTRACT

The article presents one approach used in geotechnical risk analyses for Brza voda (Poroj) river watershed, located in Macedonian Polog region. This is an area with frequent occurrences of erosion, flood and landslides events, where in certain zones of the catchment area, there are a high level of risks on exposed populated areas, traffic and energetic infrastructure and the natural environment. The methodology integrates several steps in risk analyses. As a support to the geotechnical analyses, detecting of unstable zones applying Differential Interferometry Synthetic Radar Aperture technics, Light Detection and Ranging surveys, conventional methods for landslide detection, analyses of erosion potential, hydrological and cost-benefit analyses are used. Risk assessment is based on probabilistic stability analyses for a landslide in the area of Gjermo village and shallow landslide analyses for the entire investigated area. Possible consequences form extreme hydrological and sliding events on the existing infrastructure, small hydropower plants and population are also analyzed in order to form a pair of values in risk matrix as a combination of probability of failure and economic impacts. In addition, several scenarios of susceptibility maps from shallow sliding assessments are presented. The final product is a simple risk map which is one of the elements and background for detailed design of protection measures in the catchment area.

Keywords: Erosion, economic impact, geotechnical risk, landslide, probability of failure, risk matrix

INTRODUCTION

Poroj River watershed is a part of Macedonian Polog region and it is situated in NW part of the country. This area has complex morphological elements related to complicated tectonic and geological settings (Figure 1).

The behavior of the natural system also depends on hydrological aspects. The study area is characterized by the annual average rainfall with values ranging from 600 to more than 1250 mm/year. The origin of the river is connected with an altitude of 2315 m, while the highest peak of the watershed is about 2375 m. The position of Gjermo village is in a mid of the basin at an elevation of about 1070 m, while the toe of the catchment area is related to village of Poroj at the transition from mountain to plain area, with elevations between 500 to 600 m (Figure 2).

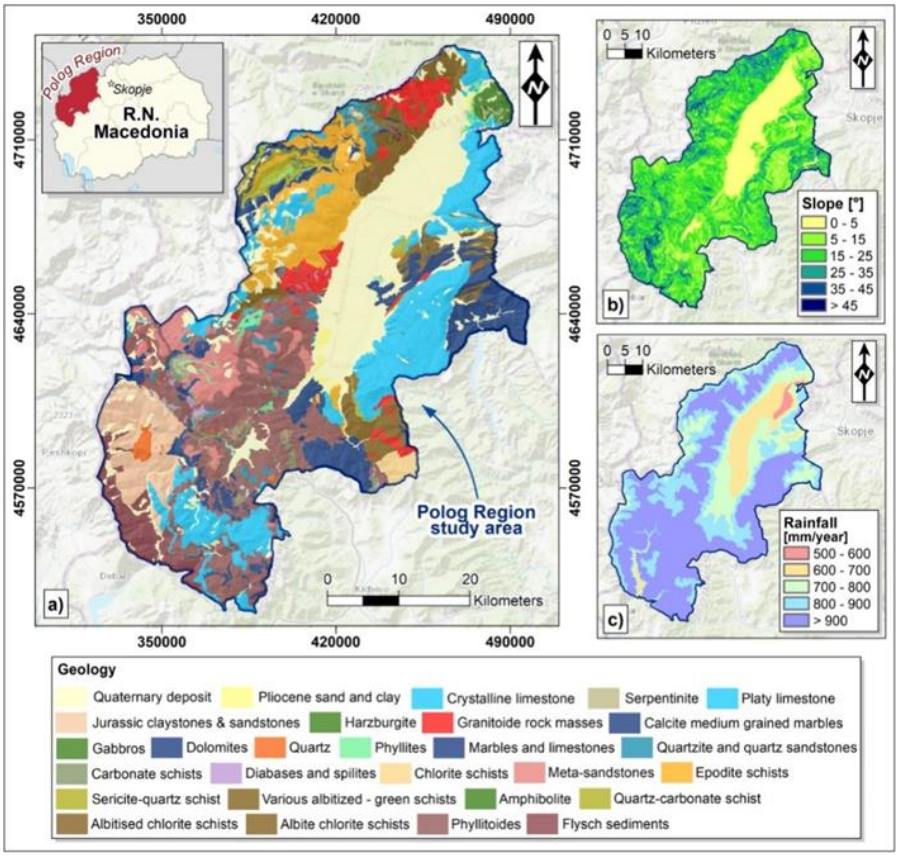


Figure 1. Presentation of study area: a) geological map, b) slope map and c) rainfall map.
Source: Jovanovski et al., 2021a.

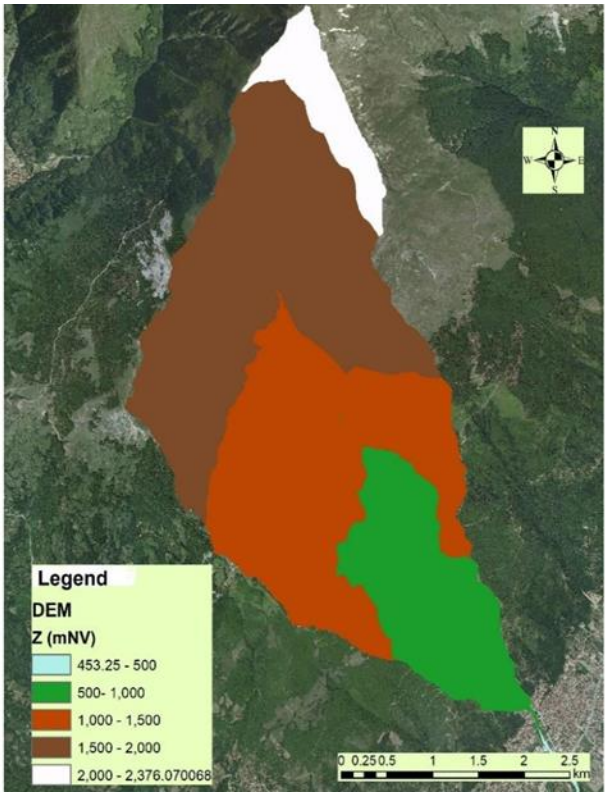


Figure 2. Digital Elevation Model of the Poroj River watershed.
Source: Jovanovski et al., 2021a.

One of the main risks on the population and infrastructure is a deep landslide located in the zone of village Gjermo. Based on historical data, the initial appearance of the landslide dates back to 1962, while several larger reactivations are observed after periods of intense rainfalls, such as in 1979, 1982 and 2006. On the other side, the densely populated village Poroj is also often affected by flooding from the Brza voda (Poroj) River. It is clear that the complicated natural and man-made factors, create preconditions for high level of risks to population and infrastructure in this watershed. Therefore, development of consistent risk management strategy is necessary. In this case, the activities are connected with preparation of multidisciplinary project funded by the United Nations Development Program (UNDP). The details can be found in Jovanovski et al. (2021a, 2021b). Main idea in the methodology is to find optimal relation between investments in protection and acceptable level of risks. The presented methodology in some elements is similar with known world practices according to Andersson et al. (2014) or Van Westen et al. (1996). Some adaptations and developments are presented based on the specifics of analyzed region.

DATA AND METHODS

The basics of applied methodology are related to step-by-step procedure and hierarchical process of analyses. Analyses of data from previous phases of investigations, erosion potential, rainfall and risk analyses, in correlation with complex socio-economic analyses for the Polog area, are very important. Simple flow-chart that explains the main steps in the methodology is presented in Figure 3.

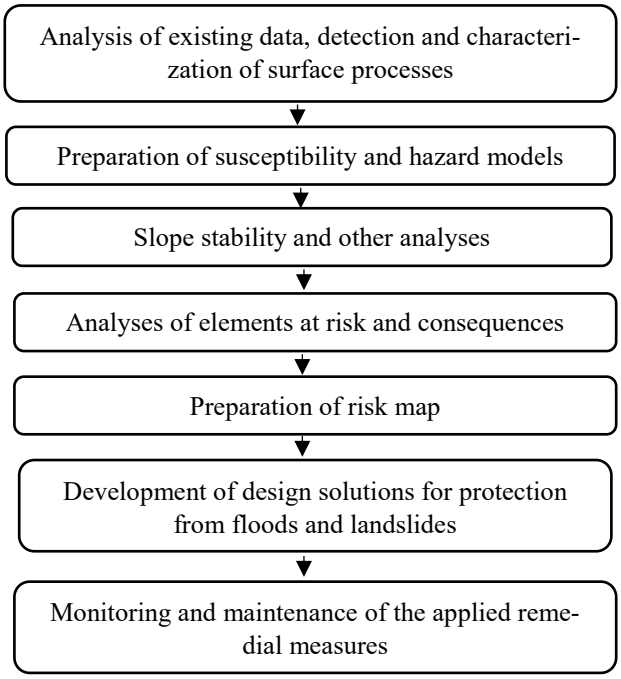


Figure 3. Flow-chart for suggested methodology of risk analyses

The leading idea in the procedure is to include consequences on the nature, infrastructure and population expressed in financial manner, supported with technical analyses. In this case,

several grades of landslide probability and grades of consequences assessed by monetary valuation are combined as pairs of values in a so-called risk matrix.

A process of detection of unstable zones starts with review of existing data from the landslide inventory, morphological, geological, tectonic, climatic, and other characteristics of the terrain. This is the basis for further analyses in regards to assessment of possible development of landslides, zonation of the area into homogeneous domains and ranking them according to the degree of landslide susceptibility, hazard or risk. The detection of landslides is done using DInSAR (Differential Interferometry Synthetic Radar Aperture) technology and LiDAR (Light Detection and Ranging) scanning, as the most advanced techniques in this field of engineering. The data on landslides obtained by these methods, together with archive data on landslides, form the landslide inventory. Details can be found in Peshevski (2015) or in Nedelkovska (2023).

The next step is to prepare landslide susceptibility and erosion potential models using the principles in analyses from "wider to narrower" areas. Some examples of prepared maps with defined erosion coefficient for the region or landslide susceptibility are presented in Figure 4.

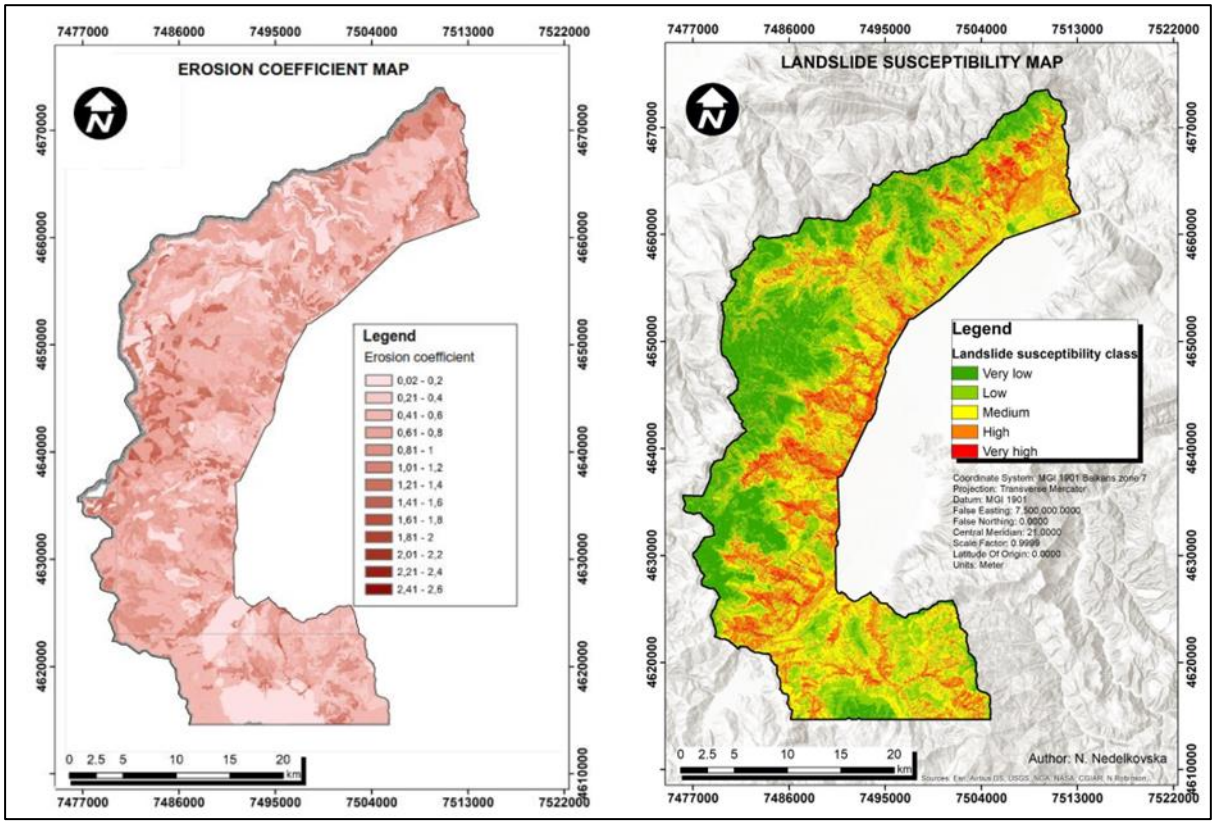


Figure 4. Presentation of maps with a defined erosion coefficient (left) and the landslide susceptibility map of the Polog area (right). Source: (Nedelkovska, 2023)

Detailed models are mainly prepared using geotechnical analyses. For whole Brza voda watershed, shallow landslide susceptibility is defined using the "infinite slope method" stability analysis, by calculating safety factor (F) of an area with the equation 1:

$$F = \frac{C_s + C_r}{\gamma_e D \sin\theta} + \left(1 - m\frac{\gamma_w}{\gamma_e}\right)\frac{\tan\varphi}{\tan\theta} \qquad (1)$$

wherein and C_r are effective soil and root cohesion (kN/m^2), D is soil depth above the failure plain (m), φ is angle of internal friction of the soil (º), θ is slope angle (º), γ_w is unit weight of water (kN/m^3), γ_e is effective unit weight of the soil (kN/m^3), and m is wetness index.

The parameter wetness index (m) is expressing the relative position of the water table H/D, where H is the saturated thickness of the soil above the failure plane, and D is the total depth of the soil above the failure plane. The method is explained by Skempton and Delory (1957). The range of values for the basic physical-mechanical geotechnical properties of lithological units in Polog region are presented in Table 1.

Table 1. Values of the basic geotechnical parameters for the lithological units

Lithological unit	Dry unit weight γ_d [kN/m^3]		Saturated unit weight γ_s [kN/m^3]		Cohesion C_s (kPa)		Angle of internal friction φ (º)	
	min	max	min	max	min	max	min	Max
Alluvial sediments	17.0	18.6	20.0	21.6	0.0	16.0	20.0	36.0
Proluvial sediments	15.5	16.5	18.5	19.5	1.0	22.0	24.0	32.0
Diluvial/eluvial sediments	16.0	18.5	19.0	21.5	10.0	30.0	25.0	29.0
Fluvio/glacial sediments	14.0	16.0	17.0	19.0	8.0	20.0	22.0	32.0

Next stage in geotechnical analyses was to define calculation model for deep sliding at Gjermo landslide. While preparing the model, some known data for the geological characteristics of the landslide was used. It should be noted that the results must be considered with precaution, because there are no enough data from detailed geotechnical investigations for the whole landslide zone. Having in mind several reactivations of the sliding processes, only residual values are relevant along the sliding surface. In this case, some minor values of the cohesion, for calculation reason, are used in the analyses. One of the applied calculation models for so-called planar failure mechanism is presented in Figure 5, while main input parameters are given in Table 2.

Table 2. Input geotechnical parameters for calculation model of Gjermo landslide.

Material	γ [kN/m^3]	C [kPa]	φ [°]
Red color (landslide body)	19.0	2.0	20.5
Yellow color (soil debris)	20.0	10.0	25.0
Green color (shist rock mass complex)	26.0	80.0	34.0

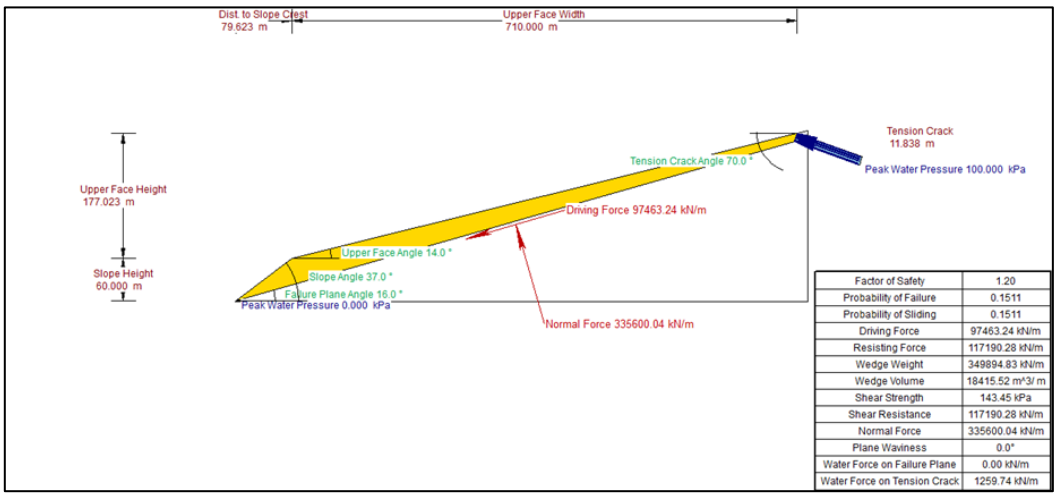
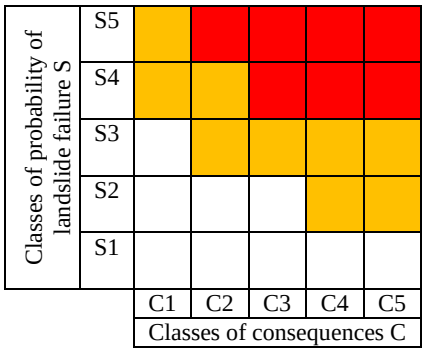


Figure 5. Calculation model for stability analyses for Gjermo landslide

Very important step in the risk assessment is the determination of the expected damages and losses from possible fast re-activation of Gjermo landslide. Exposed elements at risk from the landslide and the adopted risk matrix are presented in Figure 6.



Elements at risk of landslide	Unit
No. of affected houses	170
Total houses area (m^2)	15.274
No. of houses in low landslide risk	64
No. of houses in medium landslide risk	2
No. of houses in high landslide risk	104
Affected critical infrastructure	2
Length of affected road infrastructure (m)	1.400
Directly affected population	1.020
Total affected population	3.862
Small Hydro Power Plants	3

Figure 6. Risk matrix used for preparation of risk map combining the classes of consequences (C) expressed as socio-economic costs and classes of probability of landslide failure (S); red color is for areas with high landslide risk; orange color is for areas with medium landslide risk; white color for areas with low landslide risk.

The adopted risk matrix is composed as a combination of 5*5 consequences (C) and probability of failure classes (S). Consequences are analyzed from aspect of numbers of total affected population, possible damages on houses, possible number of people killed, damages on road infrastructure, several small Hydro Power Plants (HPP), environmental consequences, requirement of remediation, remedial costs etc. Land sliding probability is assessed using variation of input parameters in some range, by calculations for the geotechnical model presented in Figure 5. The probabilistic approach in definition of Safety Factor and Probability of Failure is used. Main results are presented further in the text.

RESULTS

Numerous scenarios are developed in the process of geotechnical analyses. For example, in definition of shallow landslide susceptibility and stability, the following scenarios were analyzed:

- Scenario 1: minimum values of geotechnical parameters and m=0.35
- Scenario 2: minimum values of geotechnical parameters and m=0.7
- Scenario 3: minimum values of geotechnical parameters and m=1
- Scenario 4: average values of geotechnical parameters and m=0.35
- Scenario 5: average values of geotechnical parameters and m=0.7
- Scenario 6: average values of geotechnical parameters and m=1

In Figure 7, results for only one scenario are presented, in order to illustrate the distribution of shallow land sliding susceptibility zones at the whole Brza voda river catchment area. The prepared susceptibility maps indicate that the shallow landslides model depends a lot on the degree of saturation. It is notable that in any scenario, the area of Germo village landslide is in the zones where factor of safety is below acceptable value, i.e. F<1.

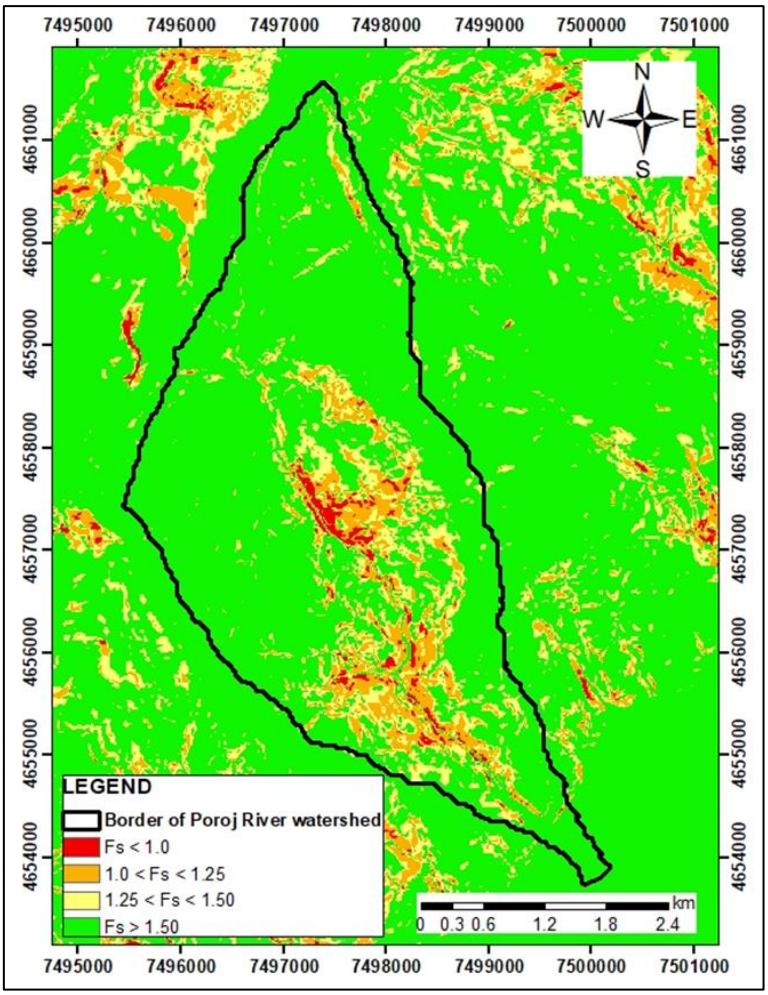


Figure 7. An example for model of shallow landslide susceptibility of Brza voda river watershed - Scenario 5-average values of geotechnical parameters and m=0.70. Red arrow indicates the area of Gjermo landslide.

Main results for the calculation model presented in Figure 5 are listed in Table 3. Several combinations for saturation of the tension crack of the landslide and some values for seismic coefficient are considered in the analyzed scenarios.

Table 3. Results from stability analyses along sliding zone of Gjermo village using ROCPLANE program

Case 1. Water in tension crack only, without seismic action	Case 2. Water along failure plane, without seismic action	Case 3. Water at tension crack, seismic coefficient 0.05	Case 4. Water at tension crack, seismic coefficient 0.08
Probabilistic Analysis Probability of Failure (PF): 0.1511 Normal Reliability Index: 1.17756 Lognormal Reliability Index: 1.20794 Factor of Safety: 1.20241	Probability of Failure (PF): 0.2709 Normal Reliability Index: 0.673166 Lognormal Reliability Index: 0.647796 Factor of Safety: 1.13397	Probabilistic Analysis Probability of Failure (PF): 0.6094 Normal Reliability Index: -0.409047 Lognormal Reliability Index: -0.453805 Factor of Safety: 1.01093	Probability of Failure (PF): 0.892 Normal Reliability Index: -1.27532 Lognormal Reliability Index: -1.25256 Factor of Safety: 0.930095

From the presented results it is obvious that factor of safety is in range of values Fs=0.93 – 1.2, depending on the chosen input variables in the calculation model. It is evident that even

small values of pore water pressures and/or minor seismic influences, lead to unstable conditions, with probability of failure PF=15-89%. Such values are usually not allowed for typical engineering cases. In practice, a minimum recommended value for Factor of safety in dry conditions is F>1.5, while for seismic actions F>1.1. In this case, it is obvious that such values are hard to be fulfilled. The results indicate that the landslide zone is close to the limit equilibrium. DinSAR analyses for the period 2015-2021 give values for velocities of landslide movements typical for slow-moving landslides. Results are presented in Table 4.

Table 4. DInSAR data for landslide velocity movement for Gjermo village: Source: Jovanovski et al. (2021)

Landslide	DInSAR average velocity [mm/year]			
	|min|	|max|	|avg.|	std. dev.
Gjermo village	4.70	38.0	9.10	13.63

As a final product from all analyses, a simple risk map is prepared (Figure 8).

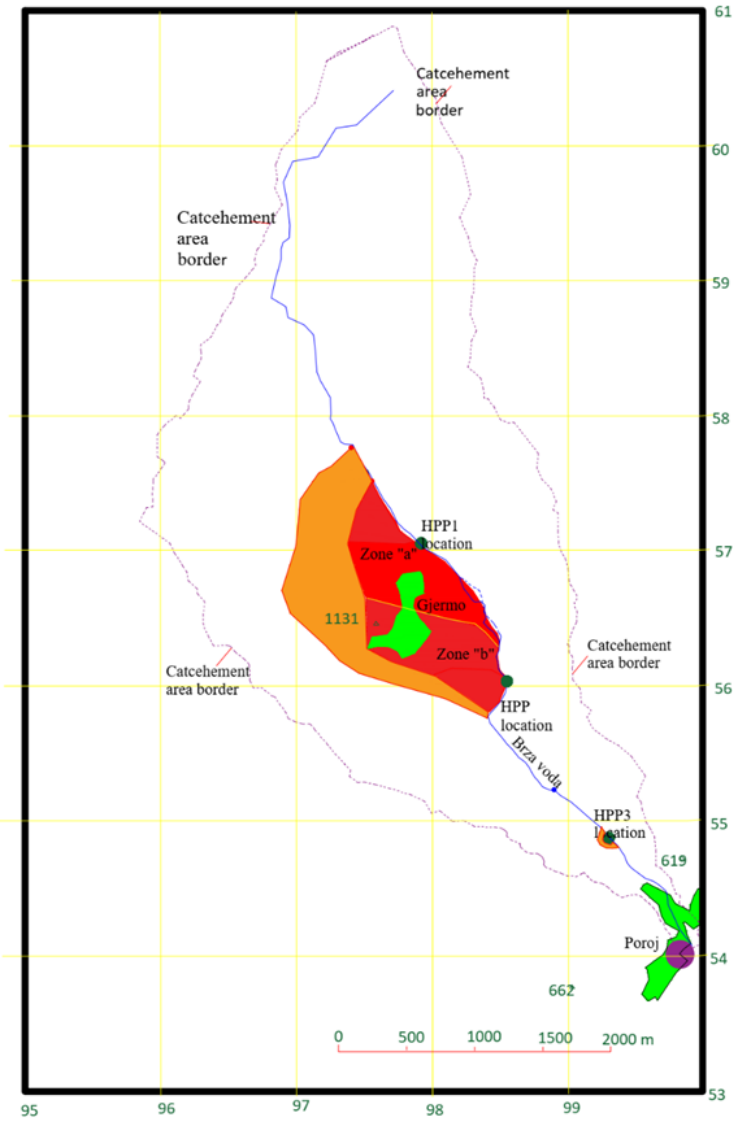


Figure 8. Risk map for Poroj River (Brza voda) catchment area (red color is for areas with high landslide risk; orange color is for areas with medium landslide risk; white color for areas with low landslide risk; green color indicates location of settlement).

DISCUSSION

The presented risk map in Figure 8 indicates that three main zones are defined from aspect of possible risk. The red colored zones are with highest risks, because they are related to the populated areas, presence of local roads and hydropower plants etc. The orange-colored zones are with medium risks, where mainly some local infrastructure is affected while the population is not directly affected. The white zones are with low risk, because only some agricultural areas can be affected by the zone of sliding.

Leading principles in risk zonation are based on the findings presented in Table 5. There, for each class, the values of probability of failure defined with stability geotechnical analyses and expected socio-economic costs representative for the case of Poroj River catchment area are presented. The zones of highest risks are marked with red color. In the analyses, some value for Hydro Power Plants (in total about 5-6 million Euros) is added to the previous prepared Cost-Benefit Analyses (CBA). The details of CBA analyses overcome the frame of this article, and they can be found in UNDP study from 2021 (Jovanovski et al. 2021).

Table 5. Landslide probability and consequence class intervals

Probability / consequence class	1	2	3	4	5
Probability of failure	<3.0E-4	3.0E-6 – 1.0E-4	1.0E-4 – 3.0E-3	3.0E-3 – 1.0E-1	>1.0E-1 1
Socio-economic cost adopted to MKD conditions in million Euros	<0.0738	0.0738-0.4305	0.4305-1.845	1.845-7.995	>8

With idea to ensure analytical connection for each value of probability of failure and socio-economic cost, in Figure 9 is presented the established correlation between the number of the consequence classes (from 1 to 5) with the value of probability of failure and of the cost.

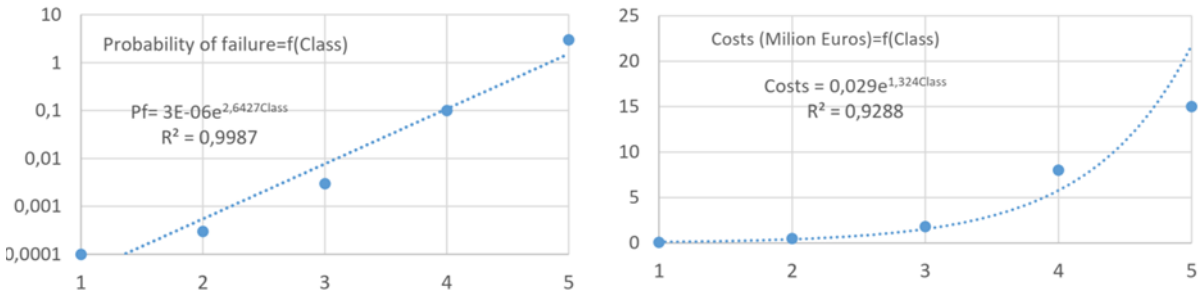


Figure 9. Diagrams for continuous definition of probability of failure (left) and costs (right) for fast prognosis of level of risks.

The presented diagrams can help in definition of risk level for each point of some analyzed area, using adequate ratings for classes. This idea is in a process of development, in a similar manner like the known polynomial interpolation method (PIM) used for solving many problems in geotechnics (Nedelkovska et al. 2017). Such methodology suggests need of integral use of data from landslide inventory, susceptibility maps, stability analyses, socio-economic cost analyses and other influential factors.

CONCLUSIONS

The presented methodology is considered suitable for Brza voda watershed. It certainly can be considered as one of the possible approaches, and we can recommend it for the level of feasibility studies. General conclusion is that the presented risk assessment method is an iterative process, which can be adjusted for other similar problems. Adjustments will depend on the specifics of each analyzed area. The importance of the geotechnical aspect is clearly visible, but this aspect shall be considered as only one link in the chain of factors in the whole system. Nevertheless, the presented methodology is "easy" and "simple" to be used by different stakeholders and municipalities, despite some limitations and uncertainties. This is also, an open field for further scientific and practical analyses.

ACKNOWLEDGMENT

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REMOTE SENSING AND FOREST CONSERVATION: COMPARING NDVI AND CORINE CLC AS TOOLS FOR IMPROVING NATIONAL FOREST INVENTORY UPDATES AND PREVENTING ILLEGAL LOGGING IN SERBIA

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ABSTRACT

Evidence convincingly shows that illegal and corrupt activities are the major underlying cause of deforestation – illegal logging contributes up to 30% of the global market, in excess of US $20 billion a year. Since so much deforestation is the result of illegal logging, we cannot rely on official production statistics to capture deforestation.

National forest inventories (NFIs) in Serbia have been carried out very rarely (every 20 years), while the last two official estimates of the forest areas (for 2011 and 2014) are very imprecise, because they are based on the cadastral data (and Serbia is well known for the lack of cadastre updating).

In this article we analysed two vegetation inventory techniques (NDVI and CORINE land cover). We clearly proved that NDVI (Normalized Difference Vegetation Index) offers local policymakers in Serbia more possibilities for sound and sustainable forest management than CORINE Land Cover: calculated forest areas obtained by CORINE land cover were even 15% larger than in the official forest inventory, while NDVI gave very precise results. The main methodological cause for such a huge discrepancies in the obtained results is that CORINE land cover (no matter how good/precise the satellite images used) doesn't go below the range of 4-5 ha space-units, while NDVI easily deals with space units of 5 m2. This is of a decisive importance for Serbia, where privately owned (agricultural and) forest land usually cover much smaller areas than 4 ha. NDVI is, also, very promising in the countries that very seldom perform national forest inventories, since it can easily provide local forest managers (especially in the municipalities with highly pronounced illegal logging, like Kuršumlija), with several, very precise, up-to-date forest inventory data (per year). Also, it has scientific objectivity that (to a large extent) can help in preventing possible corruption in the sphere of forest management. In short, in order to properly manage forests in Serbia (common resources that are difficult to be produced and easy to be depleted) NDVI clearly offers policymakers very precious possibilities for better local forest management.

Keywords: Remote sensing, Forest Conservation, CORINE land cover, Illegal logging, National forest inventory, Normalized Difference Vegetation Index (NDVI), Serbia.

INTRODUCTION

The permanent clearing of forest cover was the rule in the industrial world until few decades ago. Vast areas of Europe and North America were cleared as industrial expansion and

development of infrastructure proceeded. Deforestation today occurs largely in the tropical countries of Africa, Asia, and Latin America (Chowdhury, 2006; Steininger et al., 2001). These figures are alarming.

Most of these causes of deforestation belong to the sphere of market imperfections (Jovanović, 2012). Market imperfections arise when the property cannot be clearly defined, when the property cannot be freely transferable, when the use of the goods can not exclude the others, and when the privacy rights cannot be protected (McKean and Ostrom, 2000; Tietenberg and Lewis, 2012). There is enough available evidence that convincingly shows that illegal and corrupt activities constitute a major underlying cause of forest decline (Brack 2003; Contreras-Hermosilla, 2002). The main reason for this is that Governments (and private landowners) cannot control these illegal operations. Additionally, this lack of control can be either deliberate (often corrupt) or determined by the limitations of administrative capacity. One way or the other, illegal use of forests is rampant. (Amacher et al., 2009; Contreras-Hermosilla, 2002).

Actually, all common goods – like forest (that are difficult to exclude but subtractable) are usually completely overlooked. However, ignoring common goods (which are difficult to produce and easy to deplete) leads to tragic results (Chakravarty et al., 2012).

The main harmful factors that need to be resolved by forest management, can be divided into three categories (Dale, 2008):

1. Factors that cannot be controlled through management measures (climate changes, air pollution, and the like);
2. Factors that can be controlled through immediate management measures (primarily the breeding measures that ensure regular development of forest ecosystems);
3. Factors that can be controlled through protection measures (primarily parasitic fungi, harmful insects, rodents and the like, that constitute harmful biotic factors, which can be kept under control through direct protection measures and anthropogenic influence such as deforestation monitoring, emergency fire service that prevents fires from spreading to larger areas, etc,).

Given the importance and complexity of the problem (de Albuquerque and Rueda, 2010; Dorman et al., 2013; Freitas et al., 2005; Gallaun, 2010; Lee, 2008; Ojea et al., 2012; Pagiola et al., 2002), we are going to evaluate here the possible use of two remote sensing techniques in local forest management.

Remote sensing has been defined as the detection, recognition, or evaluation of objects by means of distant sensing or recording devices. Historically, digital remote sensing developed quickly from the technology of aerial photography and photo-interpretation science. In forestry, information extracted visually from aerial photo images is well-understood, well-used, and integrated with field surveys.

However, although remote sensing technology has (recently) emerged to support data collection and analysis methods in forest management, it is still rarely used, since remote sensing data and methods are complex, not well understood and, also, probably not well suited by those who might best use them (Franklin, 2001).

In this paper we are going to show that remote sensing data collection and analysis methods should be implemented in local forest management in Serbia. In Serbia 30% of land is under

forest. Forest management is in a very poor condition: 50% of forests are state-owned (enterprises for state forest management are in an unsatisfactory condition - their restructuring process has only started) and 50% owned privately (with a great number of small forest holdings with small economic capacity, whose owners have been over-felling their forests for decades to meet the most urgent needs of their livelihood, characterised by a poor state and fragmented holdings, unsolved property relations, which makes forest management even more difficult) (The Republic of Serbia - Ministry of Agriculture, Forestry and Water Management - Directorate of Forests, 2006).

The basic idea of this paper is to improve the local forest management system in Serbia through the use of more precise methods for the assessment of land use changes and forest inventory.

The main purpose of this research is to analyse two vegetation inventory techniques - NDVI and CORINE (praised as very efficient tools for making precise land-use and forest inventory of vast, remote areas (Meng et al., 2009) and evaluate their suitability for local forest management in Serbia. Although both of these techniques are very effective, we are going to prove that they are not equally efficient in Serbian context.

Also, the results of this study can be easily applied to the other Balkan countries, which have similar situation in the sphere of local forest management.

MATHERIALS AND METHODS

In our study we could not make any reliable comparative analysis (between official forest inventories, NDVI and CORINE results) of time series for a longer period, since national forest inventory in Serbia has been performed very rarely (last three national forest inventories - in the 20 years range: in the years 1961, 1979 and 2003-2006).

NDVI relates the spectral absorption of the chlorophyll in the red with a reflection phenomenon in the near infrared, influenced by the leaf structure type (Jovanović M. & Milanović M., 2015).

In order to obtain forest-area data with 30 m2 precision, we used NDVI and applied necessary corrections of visible red in constellation with infrared spectrum of satellite images, using following Idrisi software procedure - GIS Analysis/Mathematical Operation/Image Calculator, and then equation:

$$NDVI = (NIR - RED)/(NIR + RED)$$

in which NIR is near infrared band/spectral channel;
and RED is red band/spectral channel from the visible part of the spectrum.

This procedure enables avoidance of mistakes and deviations in the process of combining vector and raster contents, thus allowing subsequent image photo interpretation of area to be examined (Milanović at al., 2020). It is achieved by determining beforehand the same georeferenced values: coordinate system, projection and the date, for both raster and vector elements; then raster image is imported onto vector content, and contents are overlapped using the principle of layers (Milanović M. & Filipović D., 2017).

In next tables showed are different spectral bands of images that are used in this paper.

Table 1. Spectral bands of LANDSAT 5 satellite (image processing for 2011)

LANDSAT 5	Wavelength (μm)	Resolution (m)
Band 1	0.45-0.52	30
Band 2	0.52-0.60	30
Band 3	0.63-0.69	30
Band 4	0.76-0.90	30
Band 5	1.55-1.75	30
Band 6	10.40-12.50	120
Band 7	2.08-2.35	30
Band 8 PAN	0.45-0.69	15

Source: www.usgs.gov

Table 2. Spectral bands of LANDSAT 8 satellite (image processing for 2014)

LANDSAT 8	Wavelength (μm)	Resolution (m)
Band 1 Coastal	0.43-0.45	30
Band 2 Blue	0.45-0.51	30
Band 3 Green	0.53-0.59	30
Band 4 Red	0.64-0.67	30
Band 5 NIR	0.85-0.88	30
Band 6 SWIR 1	1.57-1.65	120
Band 7 SWIR 2	2.11-2.29	30
Band 8 PAN	0.50-0.68	15
Band 9 Cirrus	1.36-1.38	30
Band 10 TIRS 1	10.60-11.19	100
Band 11 TIRS 2	11.50-12.51	100

Source: www.usgs.gov

In order to more precisely distinguish sick and damaged tree areas (and their volume of timber), we applied combination of NDVI and pseudo colour composite 4,5,1, using Idrisi software (image calculator). Pseudo colour composite 4,5,1 appears in shades of reds, browns, oranges and yellows; Mid-IR (Band 5) increases sensitivity of detecting various stages of plant growth or stress; Use of TM 4 and TM 5 shows high reflectance in healthy vegetated areas.

Since official forest inventory of Topola doesn't include valid data about sick and damaged tree areas, we had to perform visual inspection (using GPS) in order to verify Idrisi results.

Hence, we compared results for two different municipality at Serbia (Topola and Kursumlija), obtained by these two different vegetation inventory techniques: a) (official EU) CORINE land cover, and b) NDVI, for year 2011 (made during spring/summer season), with c) official forest inventory for 2011 (that was performed at the end of the year). Topola municipality is located in central Serbia, Kursumlija municipality in southern Serbia, where illegal logging is very pronounced (Fig. 1).



Figure 1. Municipalities Kursumlija and Topola in Serbian and European context (author: Milanovic M, 2017)

For NDVI and, also, for creating CORINE land cover maps, we used the same LANDSAT satellite images (LANDSAT 5 and LANDSAT 8) of municipalities Kursumlija and Topola (for year 2011, made during spring/summer season, with minimum existence of clouds).

Now we are going to analyse the main methodological differences between these two vegetation inventory techniques: a) NDVI, one of the most widely used VIs (vegetation indices), and b) CORINE land cover (that is officially used in EU).

One of the main differences is that, while NDVI is related only to vegetation cover (and its status), CORINE land cover has much wider scope, and distinguishes: agricultural areas, forests and semi-natural areas, artificial surfaces (like: urban fabric, industrial, commercial and transport units), water bodies, wetlands, glaciers and perpetual snow, etc (Jensen, 2007).

NDVI, actually, is a simple graphical indicator that can be used to analyze remote sensing measurements, whether the target being observed contains live green vegetation or not (Chen, 2008). NDVI was one of the most successful of many attempts to simply and quickly identify vegetated areas and their condition, and it remains the most well-known and used index to detect live green plant canopies in multispectral remote sensing data (Campbell and Wynne, 2011; Ne Win et al., 2012, Jovanović at al. (2018). Also, NDVI has the advantage to allow comparisons between images acquired in different times (Lillesand et al., 2004).

It belongs to the Vegetation Indices (VIs), that are related to vegetation cover and status and provide useful information on biomass productivity and health condition. Vegetation Indices have a direct correlation with leaf chlorophyll content and Leaf Area Index (LAI) and vary in relation to vegetation cycle and phenology (Montandon and Small, 2008; Vohland et al., 2007). (They are also sensitive to other external factors: contribution of the soil/background optical behaviour where the vegetation does not completely cover the ground; geometry of view due to sensor angles' acquisition and to Sun position, as well as the atmospheric effects).

NDVI, like all the vegetation indices, relates the spectral absorption of the chlorophyll in the red with a reflection phenomenon in the near infrared, influenced by the leaf structure type (Wang and Tenhunen, 2004). By using NDVI, and applying necessary corrections of visible red (in constellation with infrared) spectrum of satellite images (GIS Analysis/Mathematical Operation/Image Calculator – NDVI=(NIR-Red)/(NIR+Red), we were able to obtain forest-area data with 15 m2 precision.

Upon completion of raster image processing, importing into another software package - Global Mapper - is performed. Then vector content is added, including the borders of the municipality of Kursumlija and Topola. Vector's elements on the map contains georeferenced values that correspond to values of the imported raster image in the Idrisi software.

Basic tasks include analysis and photo interpretation of elements, occurrences and processes detected on images by the specialized GIS software (Idrisi) that is used for processing of remotely sensed images through application of normalized difference vegetation index (NDVI).

This is an extremely important factor which enables avoidance of mistakes and deviations in the process of combining vector and raster contents, thus allowing subsequent image photo interpretation of area to be examined. It is achieved by determining beforehand the same georeferenced values (coordinate system, projection and the date) for both raster and vector elements, then raster image is imported onto vector content, and contents are overlapped using the principle of layers (Hájek, 2008; Johnson and Trout, 2012).

On the other hand, CORINE (Coordination of Information on the Environment) is a European programme initiated in 1985 by the European Commission, aimed at gathering information relating to the environment on certain priority topics for the European Union (air, water, soil, land cover, coastal erosion, biotopes, etc.). The main goals of the CORINE programme are: to acquire an appropriate knowledge of the environment in order to address the community politics, assessing their effectiveness acts, and to integrate the environmental and political aspects; to unify the heterogeneous thematic cartographies of Europe produced at different levels (international, national, regional, local); to update the data at regular intervals: every 5–10 years (Bossard et al., 2000). Since 1994, the European Environment Agency (EEA) integrated CORINE in its work programme. EEA is responsible for providing objective, timely and targeted information on Europe's environment (Neumann et al., 2007).

CORINE land cover has been derived by high-resolution satellite data (SPOT-HRV, Landsat-TM), through techniques of photo-interpretation (Heymann et al., 1994; Perdigao and Annoni, 1997). While CORINE database implementation is under the responsibility of the European Agency for the Environment (EEA) and image acquisition and pre-processing is centrally organized, the land cover mapping is done by member states to benefit from local knowledge. The CORINE Land Cover map has been produced for the 27 countries of the European Union (Gomarasca, 2009).

Also, procedure implies interactive controls and constant comparisons with ancillary information. The data has been validated using local cartog¬raphy and ground surveys (Genovese et al., 2001; Heymann et al., 1994; Perdigao and Annoni, 1997). CORINE land cover has, also, NDVI module for creating maps of vegetation, but the deviations of its final results are highly pronounced (because of still highly inappropriate scale for Serbian data).

For creating CORINE land cover maps for municipalities Kursumlija and Topola, image processing and digital elevation model has been made by using municipality's boundaries and, also, colour composites (LANDSAT satellite) and pseudo colour composite with bands 4, 3, 5, and adequate contrast applied. Datasets and maps for Serbia were extracted from European Environmental Agency official web-site (mainly, IMAGE2000 and CLC2000 class), with transfer data scale 1:100,000, that resulted in a very high level of imprecision (Büttner and Kleeschulte, 2005).

Of particular interest to our research is that in the original CORINE land cover project the surface area of the smallest unit is 25 hectares, although recent approach gives more thorough results, as changes < 25 ha and > 5 ha are all mapped (EEA, 2007). Nevertheless, even this (smallest) 5 ha surface areas (that are more than highly appropriate for EU countries), do not fit land-use situation in Serbia properly, as further analysis is going to show clearly.

Also, results and discussion are going to reveal some other major differences (between these two vegetation inventory techniques) that are very important for forest management in Serbia.

RESULTS AND DISCUSSION

LANDSAT satellite images of municipalities Kursumlija and Topola (for year 2011) used for NDVI and, also, for creating CORINE land cover maps, are presented in next Figures.

The following two maps (Fig. 2 and Fig. 3) are a raster NDVI Landsat satellite images, obtained through software processing and combination of individual spectral channels in the Idrisi software package. (NDVI is formed by combining satellite images of spectral channels of visible red and near infrared part of spectrum).

Having done image processing, it was concluded (Table 3) that forest areas encompass 529.83 km^2 (or 55.7 % of the total surface) of Kursumlija municipality (which is much higher than average 30% for Serbia), and 50.73 km^2 or 14.2 % of the total surface of the municipality of Topola (which is approximatelly half of the Serbian average).

Table 3. Kursumlija's and Topola's vegetation cover for year 2011 (obtained by NDVI - Idrisi software)

	Kursumlija		Topola	
	Area [km^2]	Area [%]	Area [km^2]	Area [%]
Broad-leaved forest	521.23	54.75	48.63	13.62
Coniferous forest	3.60	0.38	0.17	0.04
Mixed forest	4.93	0.52	1.93	0.54
Pastures	38.46	4.04	-	-
Transitional woodland-shrub	60.10	6.31	-	-
Sparsely vegetated areas	14.22	1.49	-	-
Land principally occupied by agriculture, with significant areas of natural vegetation	-	-	60.19	16.85
Other	309.46	32.51	246.08	68.95
Total	952	100.00	357	100.00

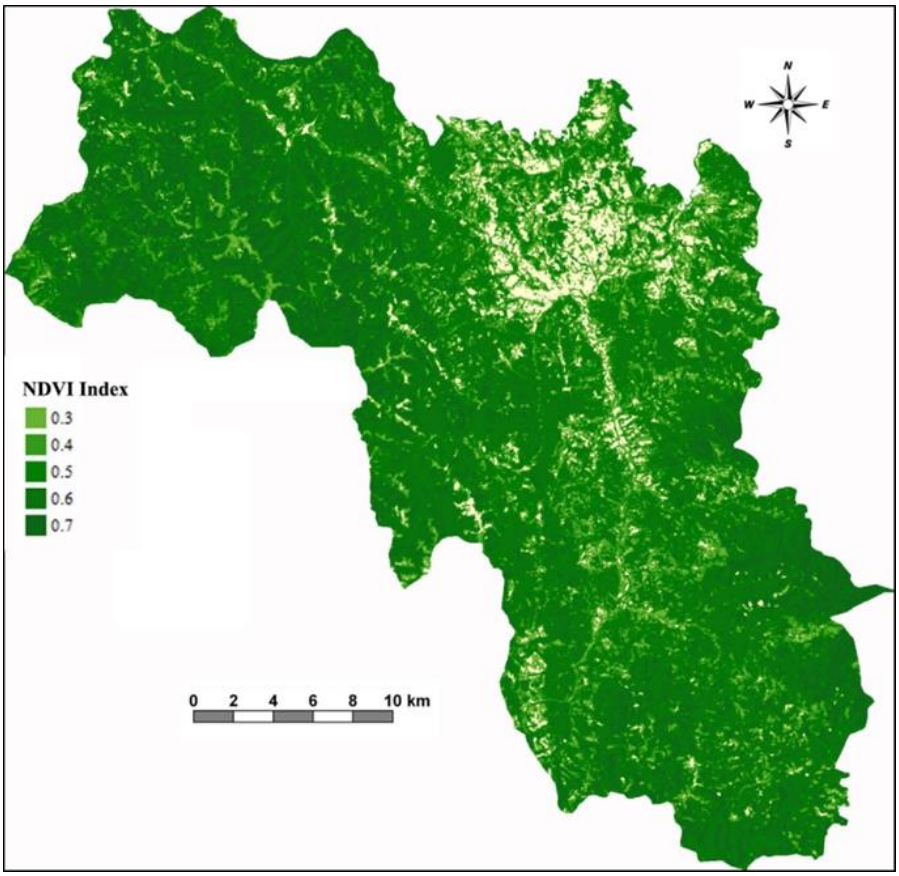

Figure 2. Kursumlija's vegetation cover for year 2011 (author: Milanovic M, 2018)

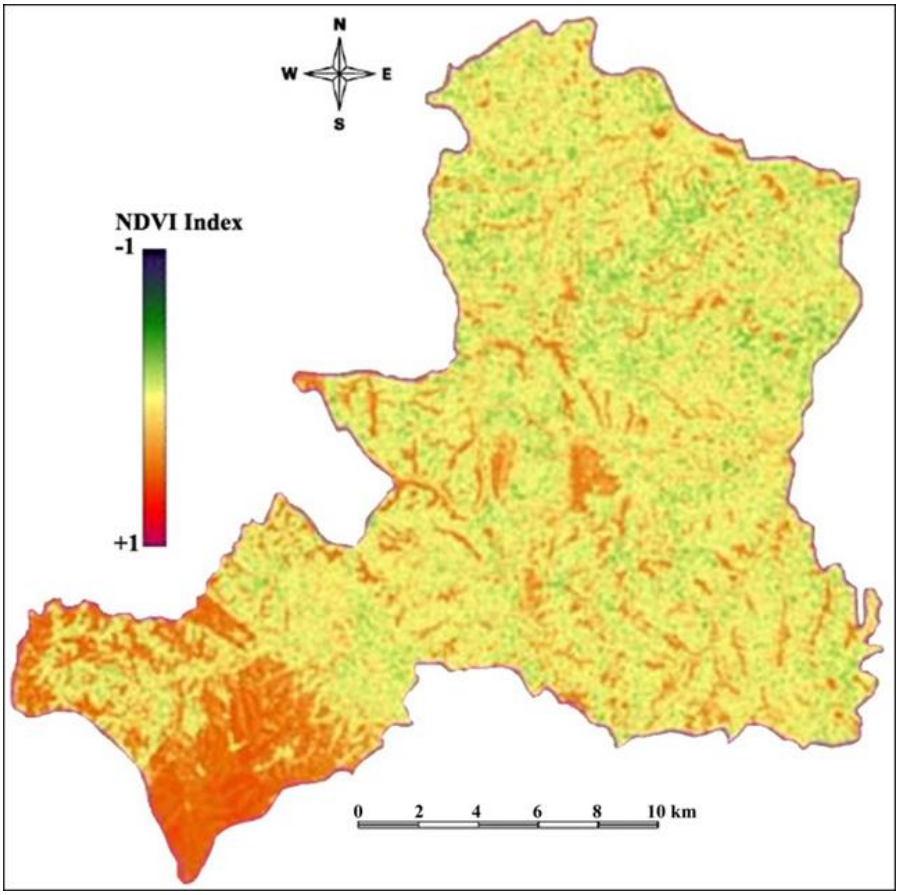

Figure 3. Topola's vegetation cover for year 2011 (author: Milanovic M, 2018)

When these NDVI results are compared with official statistical forest inventory for the same, 2011 year (SORS, 2013), there is only 1.3 km^2 of a difference for Topola's forest area, and 14.5 km^2 difference for Kursumlija (possibly because illegal logging is highly pronounced in this municipality). By CORINE land cover we obtained rather interesting results (Fig. 4 and Fig. 5).

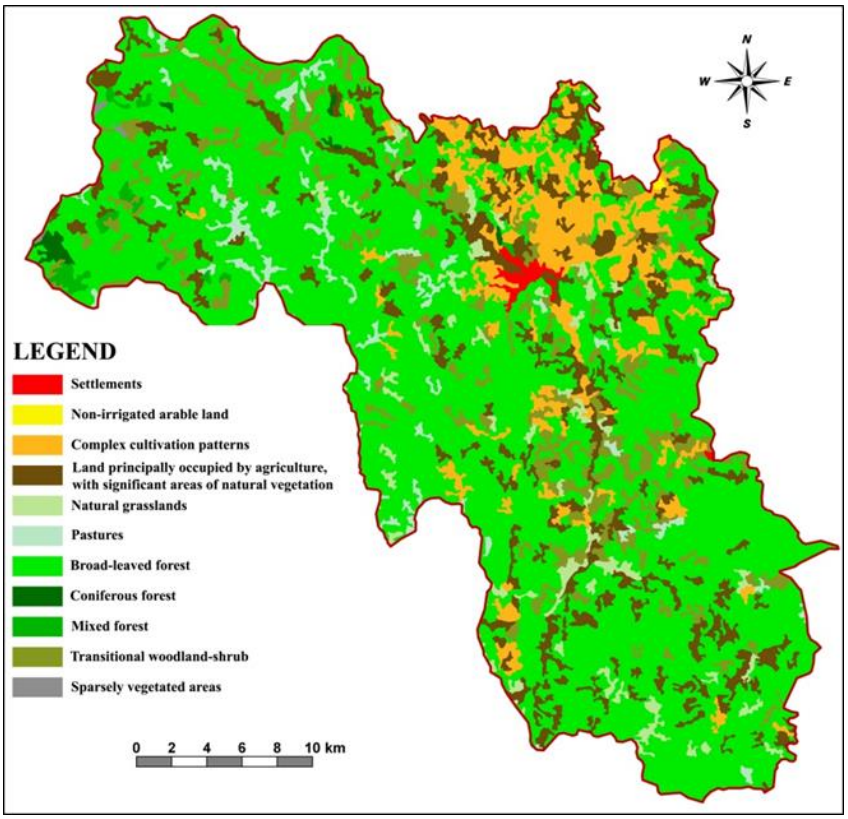

Figure 4. Kursumlija's land cover for year 2011 (author: Milanovic M, 2018)

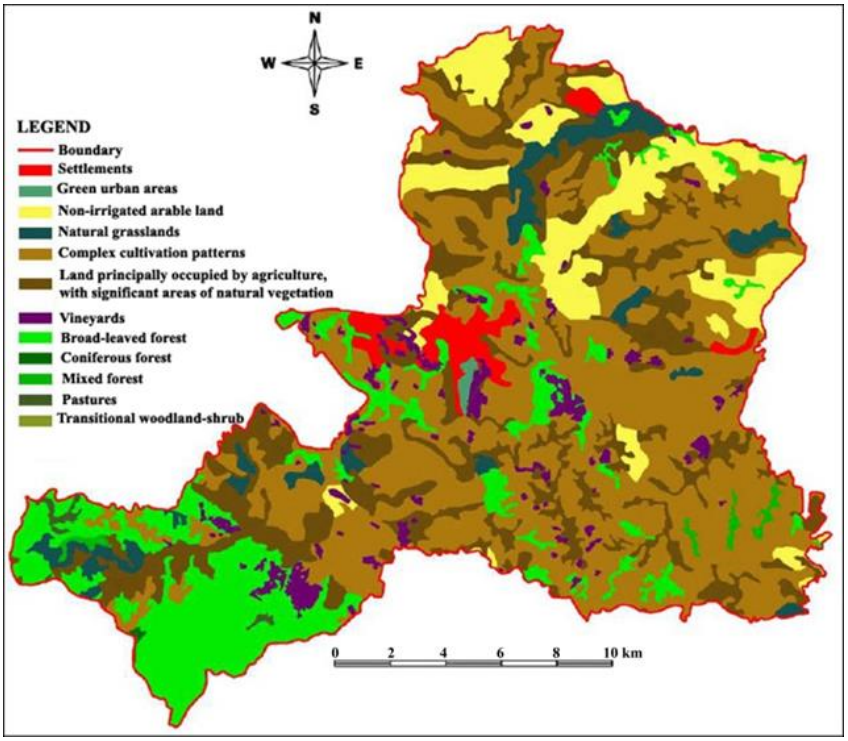

Figure 5. Topola's land cover for year 2011 (author: Milanovic M, 2018)

Table 4. Kursumlija's and Topola's land cover for year 2011 (obtained by CORINE land cover)

	Kursumlija		Topola	
	Area [km^2]	**Area [%]**	**Area [km^2]**	**Area [%]**
Settlements	4.60	0.49	9.11	2.61
Green urban areas	-	-	0.82	0.23
Non-irrigated arable land	0.42	0.04	36.51	10.46
Natural grasslands	25.74	2.73	14.44	4.14
Complex cultivation patterns	78.73	8.35	154.94	44.41
Land principally occupied by agriculture, with significant areas of natural vegetation	102.25	10.84	73.17	20.97
Broad-leaved forest	620.68	65.82	55.68	15.96
Coniferous forest	3.63	0.38	0.19	0.05
Mixed forest	6.14	0.65	2.12	0.61
Pastures	24.18	2.56	1.11	0.32
Transitional woodland-shrub	75.78	8.04	0.81	0.23
Sparsely vegetated areas	0.78	0.08	-	-
Total	**942.93**	**100.00**	**348.9**	**100.00**

When we compared CORINE land cover results with official statistical data and forest inventory for the year 2011 (Table 3, 4 and 5), some striking inconsistencies were apparent:

1. Kursumlija and Topola municipalities *total areas* (obtained by CORINE) were significantly (10 km^2) smaller than in official statistics (instead of 952 km^2 – 942.9 km^2 for Kursumlija, and instead 357 km^2– 348.9 km^2 for Topola:), and
2. Calculated forest areas (obtained by CORINE) were even 15% larger than in the official forest inventory. Kursumlija's forest area, obtained by CORINE (630.45 km^2) is even 86.2 km^2 larger than official forest inventory (544.3 km^2) for this municipality, while Topola's forest area, obtained by CORINE (58 km^2) is 6 km^2 larger than in official forest inventory (52 km^2).

Table 5. Forest area: by official statistics, and calculated on the basis of NDVI and CORINE Land Cover (2011)

Municipality	**Municipality-total area** [km^2]	**Forest area** [km^2]			**NDVI – Official statistics difference** [km^2]	**CORINE – Official statistics difference** [km^2]
		Official statistics [km^2][a]	**Calculated on the basis of NDVI** [km^2]	**Calculated on the basis of CORINE Land Cover** [km^2]		
Topola	357	52.0494	50.73	57.99	-1.3194	+5.94069
Kursumlija	952	544.2856	529.83	630.45	-14.4556	+86.1644

Source: Statistical Office of the Republic of Serbia (SORS) (2013) at the end of 2011

In short, through our comparative analysis of NDVI and CORINE Land Cover results, it became evident that NDVI is much more precise than CORINE Land Cover. Of the major significance for the results of this study, are some methodological/technical differences between these two vegetation inventory techniques. While NDVI easily deals with (minimum) space units of 5 m2, (no matter how good/precise the satellite images used) CORINE doesn't go below

the range of 4-5 ha. This proved to be decisive for Serbia, where privately owned forest parcels (which occupy half of the total forest area) usually cover much smaller areas than 4 ha.

Hence, CORINE Land Cover (at least, in its present state) proved not to be very suitable tool for local forest management in Serbia. Also, recent innovations, like combined use of CORINE and NDVI, can, probably, only give birth to some new, inspiring ideas (Chowdhury, 2006; Genovese et al., 2001).

At the same time, with NDVI we obtained some interesting results. Not only that these NDVI results (when compared with official statistical forest inventory data) show mere 1.3 km^2 (2.6 %) difference for Topola's forest area, and 14.5 km^2 (2.6 %) difference for Kursumlija (+-5% errors are allowed for this method), but it, also, gives us space for some further analysis and investigation.

Since NDVI aerial photos were taken during spring/summer season, while official forest inventory - at the end of the year, it would be expected that NDVI values are higher, not lower - at least for the Kursumlija municipality, notorious for its illegal logging. Actually, in Kursumlija (according to Srbija-sume - "Serbian forests" - state owned forest management company) more than 40,000 m3 of timber was illegally cut only during last 13 years. The main actors of illegal logging (in this southern Serbian municipality) come from Kosovo illegally, using secret, unsecured paths across the Serbian – Kosovo border, with professional equipment and mechanization to steal the timber from Kursumlija.

Obviously, governments often cannot efficiently control these illegal operations. Like Contreras-Hermosilla points out "This lack of control can be either deliberate (often corrupt) or determined by the limitations of administrative capacity. One way or the other, illegal use of forests is rampant in most forested countries. By their very nature, the true extent of illegal operations in the forestry sector cannot be known with precision, but evidence suggests that such activities are important and that they constitute an important underlying cause of forest decline" (Contreras-Hermosilla, 2002).

Since our research indicate (strong) possibility that illegal logging in Kursumlija is not properly covered with current (official) forest inventory, further (NDVI) research/study of the extent of illegal logging in southern Serbian municipalities is of the utmost importance.

In short, since municipality of Kursumlija has very large territory (952 km^2), with more than 544 km^2 (or 55.7 % of its total surface) covered with forests, and NDVI can be performed very quickly, it is obvious that NDVI can provide local forest managers (in Kursumlija) with several essential up-to-date informations (per year) about forest inventory (Bellone, 2009; Chen et al., 2004; Corral-Rivas, 2010; Fensholt et al., 2009; Martinez and Gilabert, 2009). That is of a crucial importance for preventing illegal loging, which is very pronounced in this southern Serbian municipality on the very border of Kosovo.

To summarise, forest inventory technology based on remote sensing has obviously advanced to a point where it surpasses all other types of wood inventory techniques (especially in the case of Serbia):

1) It is relatively cheap, quick and provide forest managers with a lot of essential informations, and

2) It is easy to be implemented (which is of a cruical importance in Serbia, where national forest inventory has been performed very rarely (last three national forest inventories were performed in the 20 years range – in the years 1961, 1979 and 2003-2006, latest one - with a strong financial support of Norvegian government)

3) Scientific objectivity of these methods can (to a large extent) help in avoiding possible corruption (one of the main weaknesses of Serbian economic system) in forest management

4) Since these methods can be performed very quickly, they can provide local forest managers with several up-to-date informations (per year) about forest inventory, which is of a crucial importance for preventing illegal loging, that is very pronounced in southern Serbian municipalities.

CONCLUSION

Through our comparative analysis of NDVI and CORINE Land Cover results (on the example of Kursumlija and Topola municipalities), it became evident that NDVI is much more precise than CORINE Land Cover. One of the main causes for such a huge discrepancies is that CORINE land cover (no matter how good/precise the satellite images used) doesn't go below the range of 4-5 ha space-units, while NDVI easily deals with much more refine space units of 5 m2. It proved to be of a crucial importance, since individually/privately owned agricultural and forest land in Serbia usually cover much smaller areas than 4 ha (private forests in Serbia occupy approximately one half of the total forest area).

Hence, CORINE Land Cover (at least, at/in its present state) proved not to be very suitable tool for local forest management in Serbia.

It is evident that NDVI can provide local forest managers, especially in municipalities with pronounced illegal logging (like Kursumlija), with several essential up-to-date informations (per year) about forest inventory.

Also, NDVI is very promising in the countries that very seldom perform national forest inventories (like Serbia) since it is: relatively cheap, quick, provide forest managers with a lot of essential informations; easy to be implemented; and it has scientific objectivity and (to a large extent) can help in avoiding possible corruption (one of the main weaknesses of Serbian economic system) in the sphere of forest management.

In short, in order to properly manage forests in Serbia (common resources that are difficult to be produced and easy to be depleted) especially at the local level, more comprehensive account of forests through the use of normalized difference vegetation index (NDVI) - clearly offers policymakers a more sophisticated possibilities of forest management from which to derive policy options.

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APPLICATION OF TERRESTRIAL AND UAV PHOTOGRAMMETRY FOR 3D DOCUMENTATION AND VISUALIZATION OF HISTORICAL HERITAGE

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ABSTRACT

In this paper, a scientifically based methodology is being developed for the application of an integrated approach combining terrestrial and UAV photogrammetry. The practical part refers to a digital spatial reconstruction of a Roman stone arch bridge in the village of Bogomila, Veles, which is a significant component of the historical heritage of Macedonia. The process of applying terrestrial and drone photogrammetry for 3D documentation and visualization of historical-cultural heritage involves capturing, processing, and analyzing spatial data in order to create precise representations of these objects and their surrounding environments. These techniques are essential for the creation of digital twins, which provide a virtual replica of objects and places of historical and cultural significance. Additionally, they provide immersive experiences that enhance public engagement and appreciation of cultural heritage.

Keywords: photogrammetry, cultural heritage, digital twins, 3D cartography, visualization, 3D modeling

INTRODUCTION

The intensive progress of digital photogrammetry opens incredible possibilities for mass acquisition of field data, with the aim of creating photorealistic spatial models. In this context, it is important to emphasize that digital photogrammetry plays a significant role in solving the challenges associated with 3D modeling of significant objects geometry. (Granshaw, 2019) This ensures documentation that not only protects cultural-historical heritage but also enables numerous users to explore and experience it through a digital platform, regardless of time and location. The combination of terrestrial and unmanned photogrammetry represents an advanced approach that further improves the visual characteristics of the final model. (Olson R., 2020) These models serve as digital replicas, preserving the object's form and details in a virtual environment. By generating accurate digital records, photogrammetry helps document the condition of objects, a fundamental aspect for conservation and restoration endeavors. In case of damage or loss, these models can also serve as reference base for reconstruction. Institutions can use these digital replicas to implement security measures and monitor changes in the condition of artifacts over time. Photorealistic models offer valuable insights into the structural integrity and vulnerabilities of cultural objects. Conservationists can leverage these models to evaluate risks such as degradation, structural instability, or environmental threats. This paper

aims to highlight the potentials of digital photogrammetry as a powerful tool for the promotion and protection of cultural heritage.

Study area

The ancient Roman bridge is located in the center of the village of Bogomila in the Azot region in the eastern part of the territory of the municipality of Čaška in the original catchment area of the Babuna river. It is placed in the northeast-southwest direction across the Babuna river, about 2 km from the railway station in Bogomila. The bridge belongs to the type of single-arch bridges and is classified as a significant cultural heritage site defined by the National Institution "Conservation Center" - Macedonia. The exact construction time of the bridge is not precisely determined. There is a belief among the people that the bridge dates back to the Roman period. It serves as a witness to the history of architectural development in our territory and as such is an important element for study in the context of scientific research on the development and peculiarities of construction in Macedonia. (NU National Conservation Center, 2020)



Figure 1. Map of Europe with marked N. Macedonia.
Source: (https://commons.wikimedia.org/wiki/File:Macedonia_in_Europe.svg)

Location of the bridge with geographic coordinates:

- North (N) = 41° 35’ 43’’
- East (E) = 21° 28’ 40’’
- Altitude (H) = 493 meters above sea level.

During its existence, the bridge underwent numerous interventions aimed at preserving its stability. However, with the construction of the new bridge (2019-2020), unfortunately, besides altering the surroundings, the appearance of the terrain has also changed, leading to

interventions being carried out up to the front walls of the bridge. (NU National Conservation Center, 2020)



Figure 2. The oldest found image of the bridge.
Source: (National Conservation Center – Skopje [9])

The protection and conservation of this heritage not only enriches us with historical sites and traditions, but also passes on important lessons and experiences to next generations. Therefore, investing in the protection of cultural heritage is a long-term investment in our future, preserving the richness of our culture for future generations. (Franchi E., 2017)

Purpose of research

The research aims to generate a visually rich, but also technically precise 3D model, which will serve for the documentation and conservation of the cultural-historical heritage. Additionally, the research focuses on integrating unmanned aerial and terrestrial photogrammetry, for digital spatial reconstruction of the geometry of an ancient Roman bridge in the village of Bogomila, Veles, which is a significant part of the historical heritage of Macedonia.

Methods of research

The implementation of the practical part of the work includes field activities that include the use of various modern measurement technologies, such as the DJI Phantom 4 Pro drone, the triple photo camera from the iPhone 14 Pro smartphone, the Leica Viva TS11 total station and the Leica Viva CS10 GPS. The drone is used to capture high-resolution aerial imagery of the bridge with flight paths strategically planned to achieve thorough coverage from various angles and elevations with support of Drone Deploy platform. Meanwhile, the smartphone camera is employed for capturing detailed close-up images of specific architectural features of the bridge, providing additional visual data for analysis. The GPS device and total station contribute to precise positioning and georeferencing of both the imagery and survey data, guaranteeing spatial accuracy throughout the reconstruction process.

Geodetic measurement technology cannot be functional, without support from appropriate software packages for photogrammetric processing and point cloud processing. Several applications and software tools such as Agisoft Metashape, Cloud Compare were used during the

processing of the acquired field data. The used field data for processing is discussed in the next chapter.

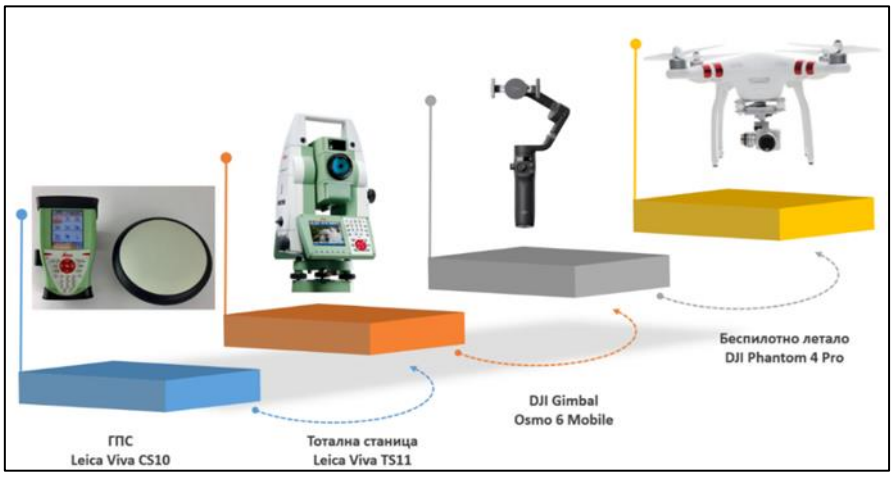

Figure 3. Geodetic measurement technology

GEODETIC MEASUREMENTS

Obtaining comprehensive and precise data, as well as creating a precise digital model with high-resolution detail, presents a challenge for every geodetic professional. It requires the use of a combination of terrestrial and aerial surveying methods, often utilizing advanced technologies like LiDAR or photogrammetry. (Lynn, 2021)
Geodetic measurements include the following activities:

- GNSS measurements for establishing a reference base for the application of photogrammetric and terrestrial surveying methods;
- Terrestrial measurements with a reflector less total station for the markers that are positioned laterally across the surface of the entire bridge, including its arched section, to enhance uniformity;
- Photogrammetric acquisition using an unmanned aerial vehicle (drone);
- Terrestrial photogrammetry acquisition utilizing triple smartphone camera.

Field data

The reference base consists of a total of 13 orientation points, including 5 markers placed on the roadway of the bridge itself, specifically on the base and surrounding areas, while the remaining 8 markers are positioned laterally across the entire surface of the bridge (Fig. 4). These markers are identified with standardized symbols for photogrammetric measurements, and their coordinates are determined using the Leica Viva CS10 GPS device in GNSS RTK method with support from the MAKPOS system, achieving an accuracy of ±2 cm. The coordinates of the markers positioned laterally across the entire side surface of the bridge, as well as inside the bridge's arch, were obtained through laser measurements using the Leica TS11 total station.



Figure 4. Orientation points used in field measurements.

After capturing the orientation points with the GNSS device and the total station, the aerial photogrammetric survey is conducted using the DJI Phantom 4 Pro drone. The flight is supported by the Drone Deploy mobile application. From the conducted aerial survey at a flying altitude of 50 meters, 82 digital images were obtained with a ground resolution of 1.1 cm/pixel. The terrestrial photographs were captured using the triple camera of the iPhone 14 Pro smartphone, which was mounted on the handheld DJI Gimbal Osmo 6 tripod for stability during shooting, ensuring better visibility and satisfactory overlap between the images. A total of 100 images were taken, focused on the geometry of the bridge, which were then merged with other images during software processing.



Figure 5. Utilization of measurement technology in the acquisition of field data

RESULTS AND DISCUSSION

Agisoft Metashape software is used to process aerial imagery from the drone and terrestrial images from the smartphone camera. The 3D model reconstruction process employed advanced software algorithms designed for close-range digital photogrammetry. In this process, the software analyzes the pixel information in the images, identifying common features or points between overlapping images, and uses this information to triangulate the position of these points in 3D space. By combining information from multiple images, the software can reconstruct the geometry and texture of the object or scene with high precision. (Milanov L., 2024)

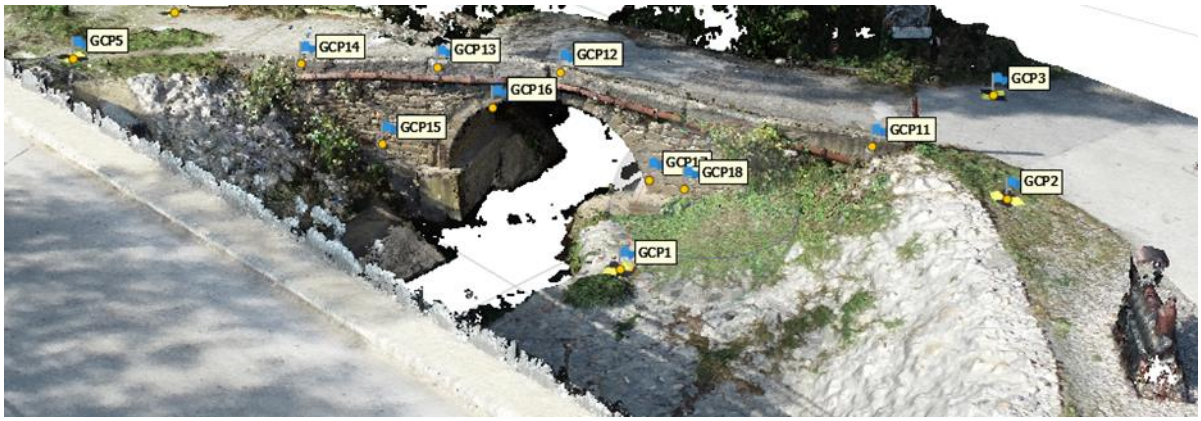

Figure 6. Graphical representation of the dense point cloud with marked positions of the control points

The dense point cloud consists of detailed 3D points, where each point represents an exact location in 3D space and contains surface geometry details. This dataset provides plenty of spatial information, allowing for advanced analysis, immersive visualization, and precise modelling. (Thomson C., 2019)

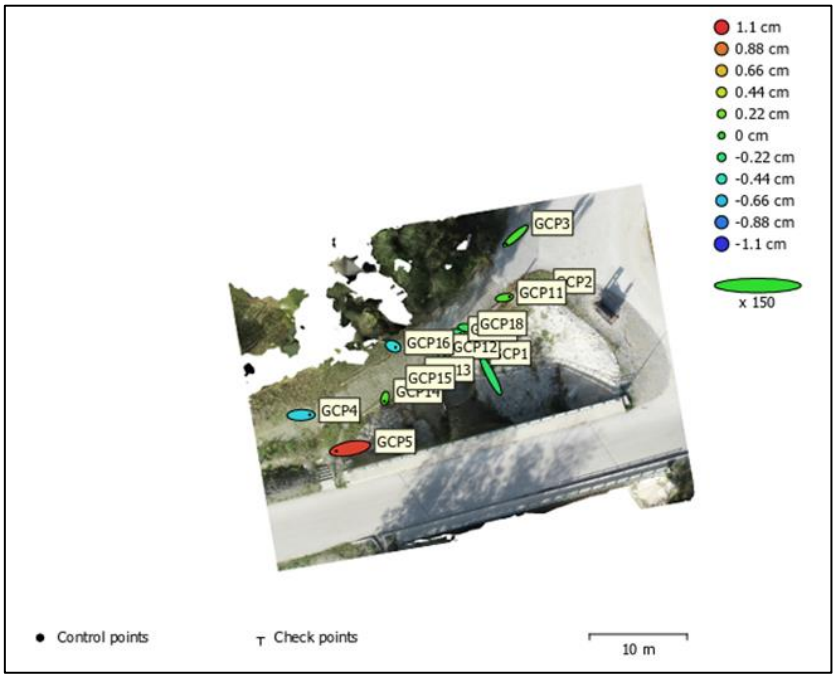

Figure 7. Ellipse of errors around the orientation points

According to the report that is generated after the photogrammetric processing in Agisoft Metashape software, we can determine the accuracy of the resulting point cloud, as well observe the parameters used in the image processing.

Photogrammetric products

Photogrammetric products encompass a range of outputs derived from photogrammetric techniques, including orthophotos, digital elevation models (DEMs), point clouds, and 3D models. (Agisoft LLC, 2019) These products serve diverse applications such as cartography, urban planning, environmental monitoring, and infrastructure development by providing accurate spatial information and detailed representations of terrain and objects.

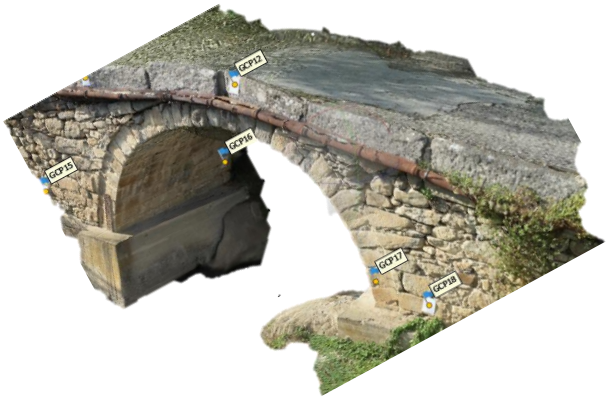

Figure 8. 3D model with generated texture.

The digital elevation model (DEM) is a computerized representation of the Earth's surface, showing terrain features and elevation. It's stored in a raster format, where each pixel represents a specific height, giving detailed insight into the landscape's topography. (Llames H. G., 2023)

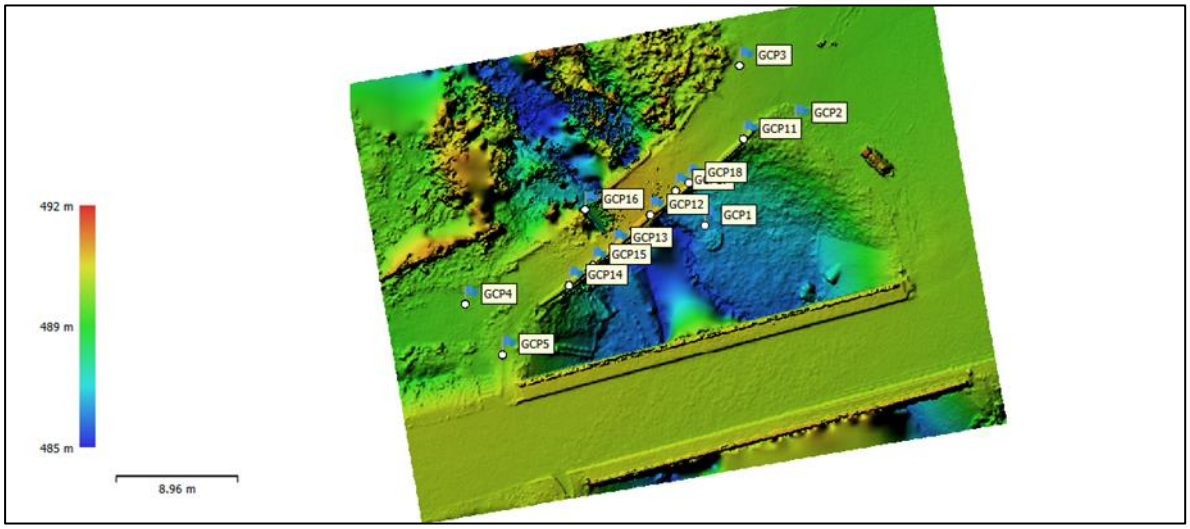

Figure 9. Digital elevation model of the site

Cloud Compare (open source) is used to process point clouds, integrating and analyzing data from various sources like laser scanning and photogrammetry. It visualizes and manipulates point cloud data to extract more information about the bridge's structure. Additionally, it offers many additional features, including comparison of two models. (CloudCompare, 2015)

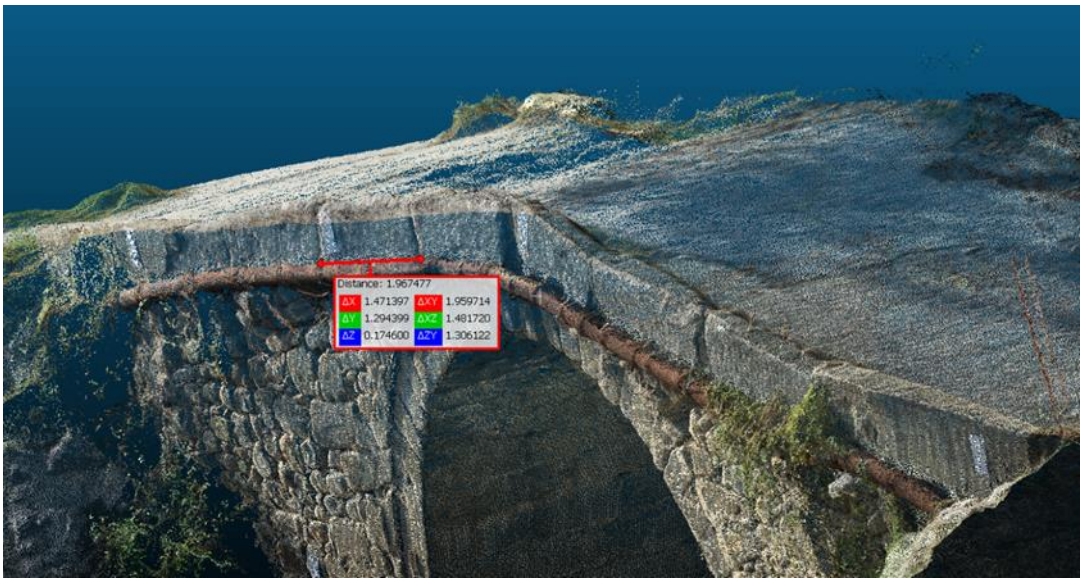

Figure 10. Measuring distance between points in the CloudCompare software.

As a practical control and confirmation of quality, distances between identical control points in the model are measured and compared with those calculated based on coordinates determined by classical methods. Extremely good values within a few centimeters are established. On the graphical representation, we can identify a difference of 5 cm in a distance of 9.24 meters.

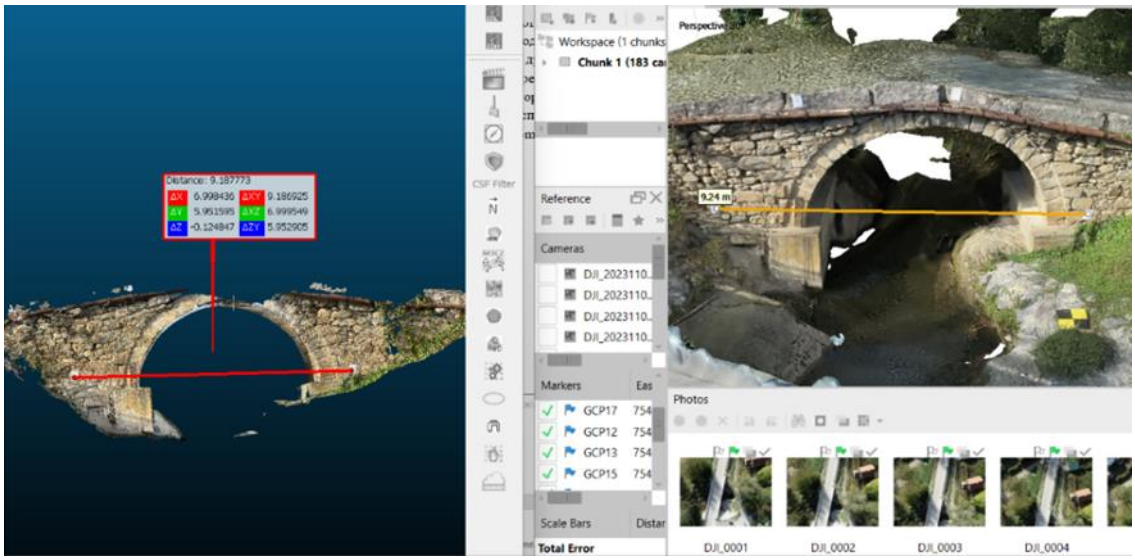

Figure 11. Graphic representation of the comparison of the same distances from two models.

The described methodology offers a robust approach to documenting and analyzing cultural heritage sites like the Roman bridge. Despite challenges in cost and expertise, the benefits

of comprehensive data collection, high-quality visualization, and versatile data analysis outweigh these limitations. Similar studies, like that of Pepe, et al. (2020), using both terrestrial and UAV photogrammetric surveys, validate the effectiveness of these methods in heritage preservation and research. As technology continues to advance and resources become more accessible, these methodologies are likely to see further improvements and expanded application in the future.

CONCLUSION

The digital reconstruction of historical heritage objects involves a multidisciplinary approach that uses different technologies and methods for the virtual representation and revival of historical objects. The investigations in this paper on 3D documentation, including terrestrial and UAV photogrammetry, combined with classical measurement methods and appropriate software packages, are performed in order to highlight the advantages and possibilities, but also the disadvantages of this approach for data acquisition and visualization, especially when dealing with objects categorized as cultural heritage. Objects of historical cultural significance are an important part of the national heritage and are subject to the risk of destruction due to various factors such as age, the effects of weather conditions, human activities, and more. Through documentation and conservation projects by creating detailed photorealistic 3D models, their value and significance is preserved for the future. These models create a virtual archive that can be used for a variety of purposes. In the specific case of implementation, of a complex combination of technologies results in the creation of a detailed and high-quality spatial model. This model significantly contributes to the documentation and conservation of the historical heritage, in this case, the ancient Roman Bridge in the village of Bogomila. This is critically important for ensuring its long-term protection and accessibility for future generations.

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GIS ANALYSIS OF STRAY DOGS ATTACKS IN THE MUNICIPALITY OF CENTAR IN THE CITY OF SKOPJE

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ABSTRACT

In the last few years, in addition to other municipalities, the Municipality of Centar, as a central urban part of the City of Skopje, has been faced with the presence of a number of stray dogs, which threatens the safety of the citizens. The expansion of street stray dogs creates an ongoing current problem that covers all age groups of citizens because dog bites in humans are a complex problem that covers public health and the welfare of the population and animals. This paper covers the recorded attacks by stray dogs, the demographic predisposition, and the spatial and temporal characteristics of bites by stray dogs in the territory of the Municipality of Centar in the period from 2018 to 2023. A total of 639 attacks and bites by stray dogs, which were registered in the regional units of the Ministry of the Interior, were analyzed. From the total number of recorded bites, 596 (93.27%) attacks were committed by a single stray dog, while 43 (6.73%) attacks were by a pack of dogs. Also, in 231 (36.15%) cases, the attacked persons are female, while in 407 (63.85) cases, the attacked persons are male. Regarding the age of the attackers, 58 cases (9.06%) are minors (0–17 years), while 581 cases (90.94%) of the attackers are adults. The aim of the paper is to locate the hotspots of attacks by stray dogs throughout the municipality by applying geographical information methods. Also, by using GIS, it is possible to create the so-called "geography of homeless animals" of the studied territory, which will allow a better understanding and may even lead to better management of the situation of stray animals.

Keywords: Stray dogs attack, GIS, Medicine geography, Skopje, Municipality of Centar

INTRODUCTION

According to the Law on the Protection and Welfare of Animals, published in the "Official Gazette of the Republic of Macedonia", no. 149/2014, Article 28, the municipalities in the city of Skopje, are competent to collect homeless dogs, i.e., unregistered dogs and registered dogs, if they are found on public lands without the presence of the owner, and to temporarily place them in appropriate facilities - shelters. In these facilities, elementary protection of the animals from unfavorable weather conditions should be ensured, and their effective closure should be estabish (Official Gazette of the Republic of Macedonia, 2014). Stray dogs in the last few years have represented a significant security problem for the residents of the municipality of Centar, because with each attack, the safety and health of the population are directly threatened, but at the same time, humans are one of the main factors for the appearance of the large

number of street dogs that appear through the streets of Centar. However for solving the problem with stray dogs, one important link is missing, and that is the registration of dog kennels (Trajkov, 2023). But with the adopted proposal-amendments and additions to the Animal Welfare Law, the establishment of a system for controlling the reproduction of dogs is foreseen through the registration of kennels and the registration of registered dog breeders. With this measure, owners of pet dogs who do not want to keep their pet for reproduction (do not want to register as a kennel or registered dog owner) are required to sterilize the pet (FVA, 2022). It is also estimated that irresponsible pet ownership and abandonment are two of the biggest sources of homeless dogs in urban and rural areas.

There is no official number, record or national registry of street dogs within the Municipality of Centar, City of Skopje, in the Republic of North Macedonia, but in the registry of the FVA (Food and Veterinary Agency), 72.156 pets are registered, of which 69.234 are dogs (FVA, 2024). But the number of attacks and bites by stray dogs is not only a problem in our country, but also in European countries (Alberghina et. al., 2023; Cianciara et al., 2022; Sarenbo & Svensson, 2021; Mara et al., 2018; Fragoso et al., 2022; Rosado, 2008), in the territory of Australia (Rajshekar et al., 2017) and the United States of America (Langley, 2009; Bregman & Slavinski, 2012; Vertalka et al., 2018), Mexico (Quezada-Nolasco et. al., 2023; Brock, 2018), Uruguay (Roman et al., 2023), Kenya (Kung′ u, & Brodbelt, 2023), India (Masthi & Vairavasolai, 2016) where numbers are increasing every year.

Usually, the attacks are incited and carried out by the street dog, but there are also rare cases when the main initiator of the attack and bite is the person himself (Trajkov, 2023). Also, several studies indicate that the male population is most affected by dog bites (Alberghina et. al., 2023; Alam et al., 2020; Benfield et al., 2010; Bregman & Slavinski, 2012; Roman et al., 2023; Rosado, 2008; Morgan & Palmer, 2007; Georges, & Adesiyun, 2008), where also in this paper, based on the processed data, it is confirmed. However, no relationships were found between income and the level of education, marital status, or ethnic and racial composition of persons attacked by stray dogs. However, there is limited, incomplete information on dog bites in Skopje, due to the lack of a comprehensive reporting system, which would include several institutions such as outpatient centers, hospitals, and the food and veterinary agency, since the data is reported exclusively in the regional centers of the Ministry of Internal Affairs on the territory of the City of Skopje. According to the practice guideline for medical care for bite wounds, published by the Ministry of Health (Ministry of Health, 2015), dog bites are the most common, followed by cat and human bites, dog wounds become infected in 5-20% from cases and bites on the limbs and face can be accompanied by invoices.

AIM OF STUDY

The main purpose of the study is to represent the spatio-temporal analysis and hot spots of stray dog attacks in the territory of the municipality of Centar in the period from 2018 to 2023, through the application of Geographic Information Systems.

DATA AND METHODS

Study Area

The Municipality of Centar covers the central part of the City of Skopje. This includes Macedonia Square, both banks of the Vardar River, and part of the extreme northern slopes of the Vodno Mountain. Within its territory, there are several administrative buildings, including the Government, Parliament, ministries, state offices, agencies and administrations. The rectory of the Skopje University "St. Cyril and Methodius" together with several faculties and the assembly of the city of Skopje. On the northern side, the municipality of Centar borders with the municipality of Chair, on the northeast it borders with the municipality of Gazi Baba, while on the eastern side, Centar borders with the municipality of Aerodrom, and it extends from the International Railway and Bus Station, to the Tobacco Factory and the Ministry of Interior (Ministry of the Interior). On the southeast side, Centar borders the municipality of Kisela Voda, while on the south side, the municipality of Centar borders the municipality of Karposh, and it stretches from the Vodno intersection to the old part of the City Park in Skopje (Agency for Real Estate Cadastre, 2024).

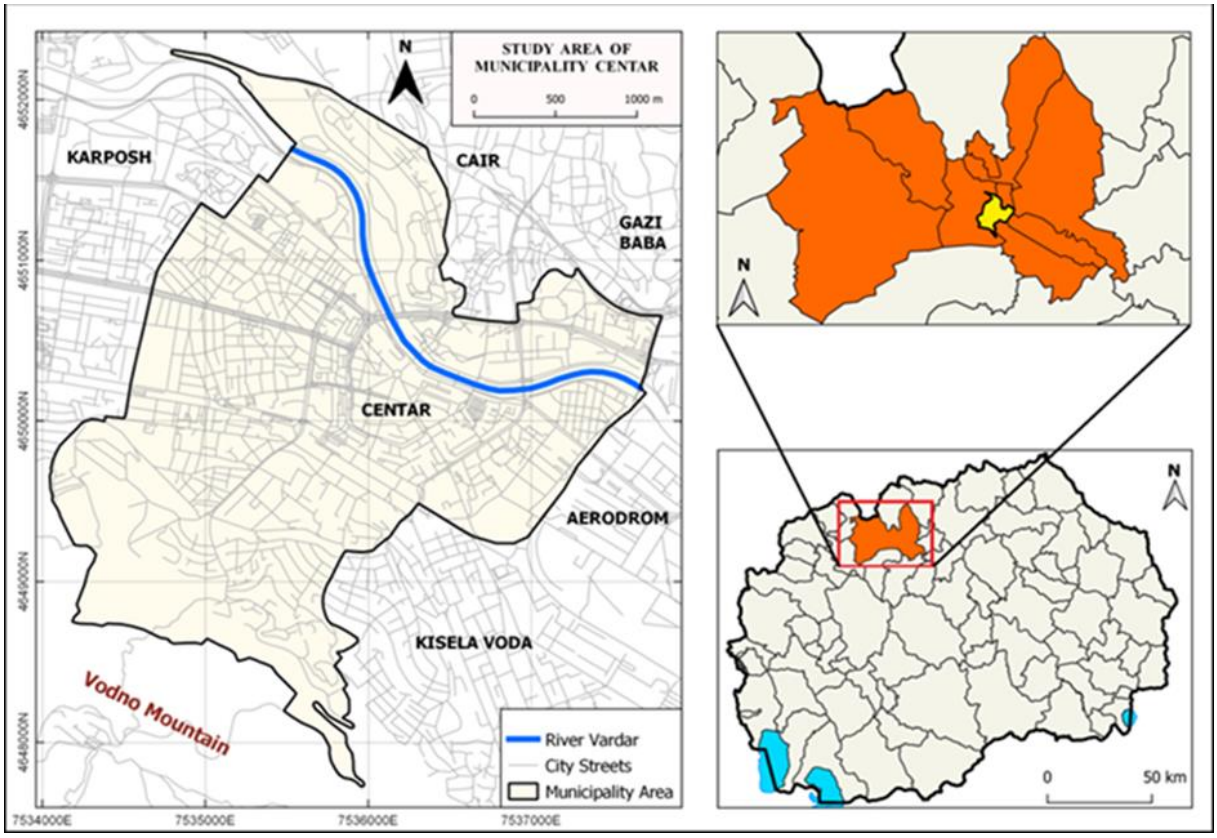

Figure 1. Municipality of Centar, City of Skopje.

Within these borders, the municipality of Centar covers an area of 7.52 km^2 and borders five neighboring municipalities. According to the absolute altitude of 320 meters, it is counted among the lowest municipalities in the country (Municipality of Centar, 2023). It has a northeast-southwest direction. Based on the last consolidated census of 2021, 43,893 inhabitants live

within the municipality (State Statistics Office, 2022) and it is one of the most densely populated municipalities in the Republic of North Macedonia, with 5,837 people per km^2.

Data collection

Since dog attacks are a complex problem, characterized by a spatial-temporal character, they are reported to the regional units of the Ministry of Interior. Reported cases of attacks by stray dogs are mostly reported by the attacked persons themselves, during the same day, while for minors, the cases are reported by their parents (Daily Bulletin, Ministry of Interior). The data on stray dog bites, which is publicly available on the website of the Ministry of Internal Affairs. For this paper, data spanning from 11.01.2018, to 29.12.2023, was analyzed. It is necessary to state that at the beginning of the first three years of reporting stray dog attacks until 19.05.2020, in addition to the basic data on the time and location of the event and the age and gender of the attacked person, it was also recorded in which area of the body, the affected person was attacked by the stray dog, while from 20.05.2020, are no longer entered in the daily bulletins, which significantly affects the overall analysis of stray dog attacks.

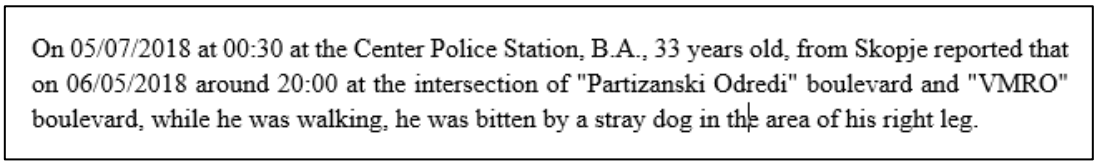
On 05/07/2018 at 00:30 at the Center Police Station, B.A., 33 years old, from Skopje reported that on 06/05/2018 around 20:00 at the intersection of "Partizanski Odredi" boulevard and "VMRO" boulevard, while he was walking, he was bitten by a stray dog in the area of his right leg.

Figure 2. Excerpt from the daily bulletin of the Ministry of the Interior for 07 May 2018. (Source: https://mvr.gov.mk/izvadok-od-dnevni-nastani/1118). Translated by the authors

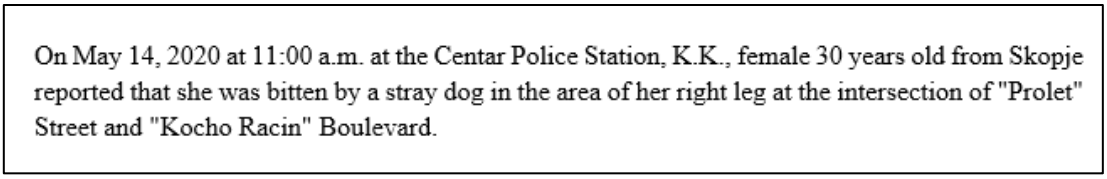
On May 14, 2020 at 11:00 a.m. at the Centar Police Station, K.K., female 30 years old from Skopje reported that she was bitten by a stray dog in the area of her right leg at the intersection of "Prolet" Street and "Kocho Racin" Boulevard.

Figure 3. Excerpt from the daily bulletin of the Ministry of the Interior for 14 May 2020. (Source: https://mvr.gov.mk/izvadok-od-dnevni-nastani/1862). Translated by the authors

In terms of spatial data, the administrative boundaries of the municipality of Centar and the settlements that are an integral part of the studied area are taken from the publicly available websites of the Agency for Real Estate Cadastre of the Republic of North Macedonia (Agency for Real Estate Cadastre, 2024) and the urban plan of Municipality of Centar. In addition, for the spatial layout of road infrastructure, green areas and parks, educational institutions, and other infrastructure facilities, data from Open Street Map (OSM, 2024) and desktop Google Earth Pro (Google Earth, 2024) were taken from Open Source.

Methods and Analysis

Because the research period span from 2018 to 2023, with a total of 639 reported cases of attacks by stray dogs, a descriptive method of analyzing and presenting the data will be approached, calculation of the total incidence of bites as well as the incidence by sex, stray dog

attacks by days, months and spatial locations are included. Statistical data were calculated using Microsoft Excel. Spatial analyses were also conducted simultaneously using QGIS (version 3.32.2) software, which was used in the development of map displays of hotspots using dog bite data identified from Ministry of Internal Affair daily bulletin data as well as census data of the population in 2021 as official data for the population in the municipality of Centar.

RESULTS

Based on the analyzed data on the reported bites of stray dogs, it was recorded that most of the attacks take place in an open space, mostly on the trim paths and the quay of the Vardar river and through the city boulevards, i.e., where there is an increased frequency of people. As stated in the data and methods section, until May 19, 2020, in the daily bulletins of the Ministry of the Interior, in addition to the time, location, age and gender of the attacked person, it was recorded in which part of the body the injury occurred from the attack of a stray dog. So out of a total of 639 reported attacks, 255 registered cases have a record of the type of injury, while in 384 registered cases, that information is missing

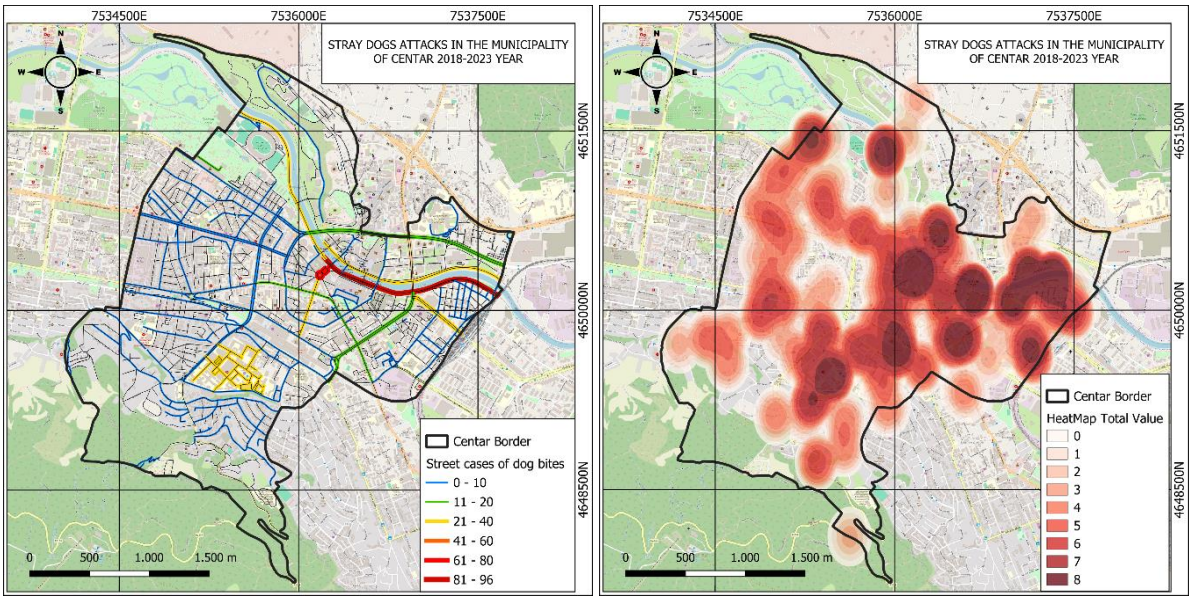

Figure 4. Stray dogs attack in the Municipality of Centar, period 2018-2023.
Left map: Stray dog attack per streets. Right map: Heatmap of all stray dogs attacks.

According to the age of the attacked people, out of a total of 639 reported cases, minors under the age of 18 are 58 registered cases, i.e., 9.07% of the total number of cases reported to the Ministry of the Interior, while 588 registered cases are people aged 18 and over. Of them, 57% are male minors (33 reported cases), while 43% of those attacked, are female (25 cases). According to the distribution of bites by day, most minor children are attacked on Mondays and Saturdays, while the lowest number of registered attacks are on Fridays. Regarding the time of occurrence of an attack by stray dogs, the most were registered between 20:00 and 21:00 pm, while the lowest number of attacks were registered between midnight and 07:00 in the morning.

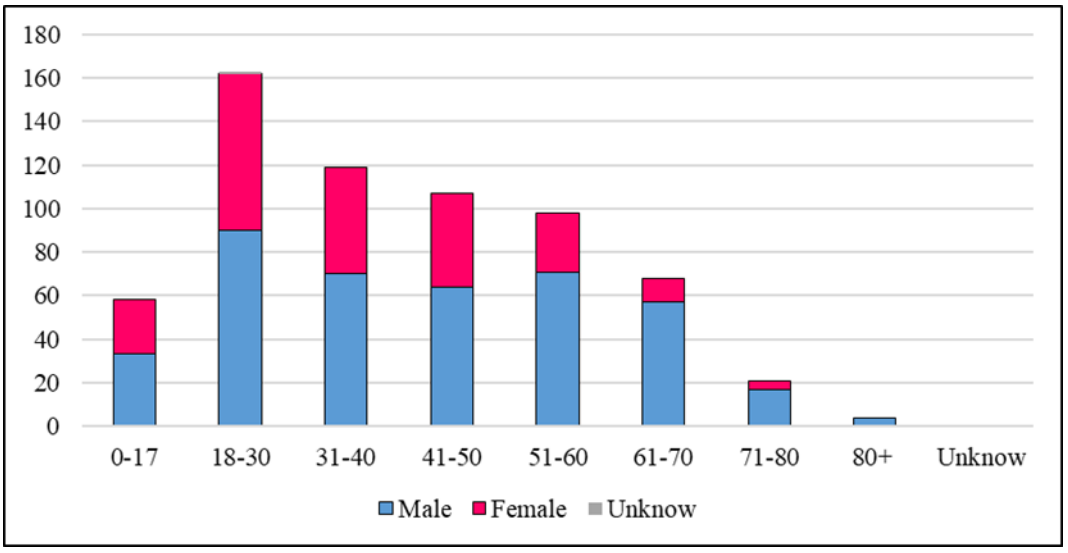

Figure 5. Age and gender of persons attacked by canines in Canter, year 2018-2023.

According to age, there are 61 registered cases of stray dog bites (9.54% of all reported cases) among the individuals over 65 years of age. The representation of young people up to 18 years old and people over 65 years age has an almost equal percentage share in relation to the total number of reported cases of attacks by stray dogs. According to the gender structure, 10 cases of injured persons are female (16.4%), while 51 cases of injured people are male (83.6%). In terms of the time of occurrence of bites from stray dogs on individuals aged 65 and over, the most common time of bite is between 1-2 pm (11 reported cases), then from 11-12 am (10 reported cases), while in the late night hours from 21:00 to 06:00 in the morning only one case was reported. We can notice that stray dogs most often attack the individuals over 65 years of age in the morning and afternoon during the day, while at night, the number is drastically lower. If the overall data is taken, out of 639 reported cases of dog attacks, 407 reported cases are male (63.7% of cases), while 231 reported cases are female (36.15% of cases). Only in one case the gender of the person who was injured by the bite of a stray dog was not specified.

In 2018, the incidence rate was 19.14 per 10,000 inhabitants, and the highest value was in 2019, when it was 36.38. This is due to the increased number of reported cases (161 bites), which is twice as high as the previous year in 2018 (84 bites). From 2018 until 2022, there has been a continuous decrease in the incidence rates, which in 2020 is 26,65, in 2021 is 21,87 and in 2022 is 18.23, because in that year, the number of reported cases was 80, and it represents the lowest number of cases in the entire six-year examined period. In the next year, 2023, a slight increase in the incidence is recorded, which is 23.01, because in that year 101 cases were reported in the Municipality of Centar.

According to the representation of the gender structure, the incidence of bites among the female population is 98.28 in a period of 6 researched years, while the incidence of bites from stray dogs among the male population in the municipality of Centar is 199.62, i.e., the incidence in the male population is twice as high as the female population, although the female population is 53.5% of the entire population in the Centar, and 46.5% of the population is male.

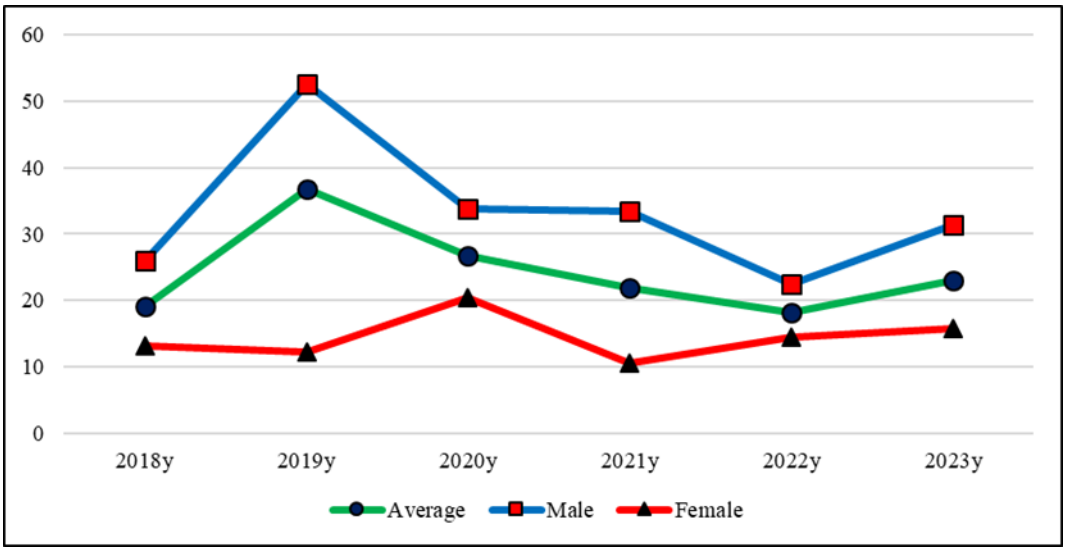

Figure 6. Incidence rate of dog bites in Centar per year.

According to the time interval of attacks by stray dogs, in the entire six-year study period, the most bites occurred in the period from 11:00 to 12:00, with a total of 86 attacks (13.45% of the reported cases), while in the period from 05:00 to 06:00, not a single case was reported.

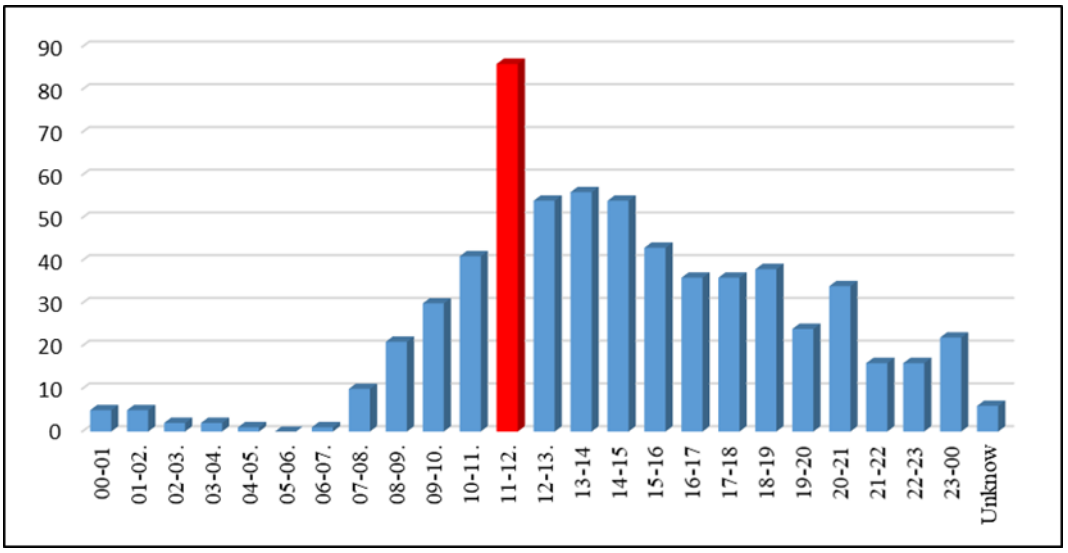

Figure 7. Number of registered bites from dogs per hour in Centar, period 2018-2023

Based on the data on the time of the bite, we can record that there is a gradual increase in the number of attacks by stray dogs in the morning hours, the highest representation is in the afternoon hours and then follows a decrease towards the night hours. According to the time of attack, there is a trend of increasing cases of attacks by stray dogs, especially in the morning and early morning hours, with a maximum peak in the period from 11-12 am with a gradual decline towards night hours, with the exception of small increased deviations in the period from 8-9 pm and 11–12 pm. These numbers are due to the increased movement of students towards educational institutions and employees in the public and private sectors. The lowest number of reported cases are in the early hours of the morning from 04 to 08 am, because during that period of the night, almost the entire population within the municipality is in their

homes. As a specific feature, it can be pointed out that during the working days, most attacks took place between 11:00 and 12:00, but during the weekend, this is not the case. Thus, on Saturday, most bites occurred between 11:00 and 13:00, while on Sunday, most attacks by stray dogs were recorded between 17:00 and 18:00. These values are due to the fact that, unlike weekdays, where there is an increased movement of the population in the morning, during the weekend, this is not the case, so the time with the most bites is in the afternoon. Also, according to the reported cases, during the weekend, most of the cases with dog attacks are in the late afternoon and night hours of the day.

In addition to the temporal character, dog attacks during the working week were also analyzed. According to the cases reported to the Ministry of the Interior, the most attacks were registered on Monday (118 bites), Tuesday (100 bites), Wednesday (114 bites), Thursday (93 bites), Friday (78 bites), Saturday (76 bites) and Sunday (60 bites).

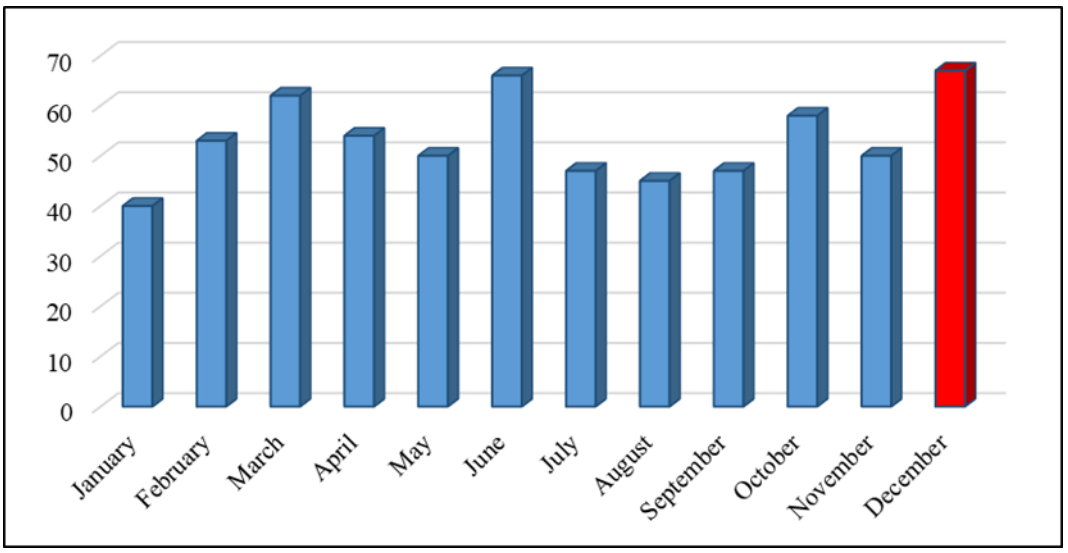

Figure 8. Total bites per month, period 2018-2023.

According to monthly and annual statistics of reported cases of bites from stray dogs, the number varies by month and year. Regarding the months, in the period from 2018 to 2023, December had the most bites is with 67 reported cases, followed by the months of June (66 reported cases) and March (62 reported cases), while the months with the fewest bites from stray dogs are the months January (40 reported cases) and August (45 reported cases). Based on the data shown in Figure 7, we can state that the bites vary by month; that is, the months with the highest number of bites are the months when the annual seasons begin.

In 2018, a total of 84 cases of attack and bite by a stray dog were reported within the Municipality of Centar. The most bites were recorded in the month of February (17 cases), and the lowest number in the month of November, only one case. In the following year 2019, a double growth of almost 91.67% was recorded in the number of reported attacks by street dogs, i.e., 161 reported cases. Months with the highest number of dog bites are April (22 cases) and March (21 cases), while the lowest number was recorded in January with four reported cases. The increased number of attacks can also be observed in Figure 5, where the incidence rate is 36.38 and represents the highest measured rate in the entire examined period.

Table 1. Registered dog attacks in Municipality of Centar

Months	2018	2019	2020	2021	2022	2023	Total
January	2	4	5	7	10	12	40
February	17	5	10	9	7	5	53
March	5	21	7	14	6	9	62
April	6	22	7	6	6	7	54
May	8	14	13	9	4	2	50
June	10	20	4	14	7	11	66
July	5	10	10	9	8	5	47
August	6	7	10	7	4	11	45
September	5	12	8	5	6	11	47
October	7	18	18	2	6	7	58
November	1	16	10	7	8	8	50
December	12	12	15	7	8	13	67
Total	84	161	117	96	80	101	639

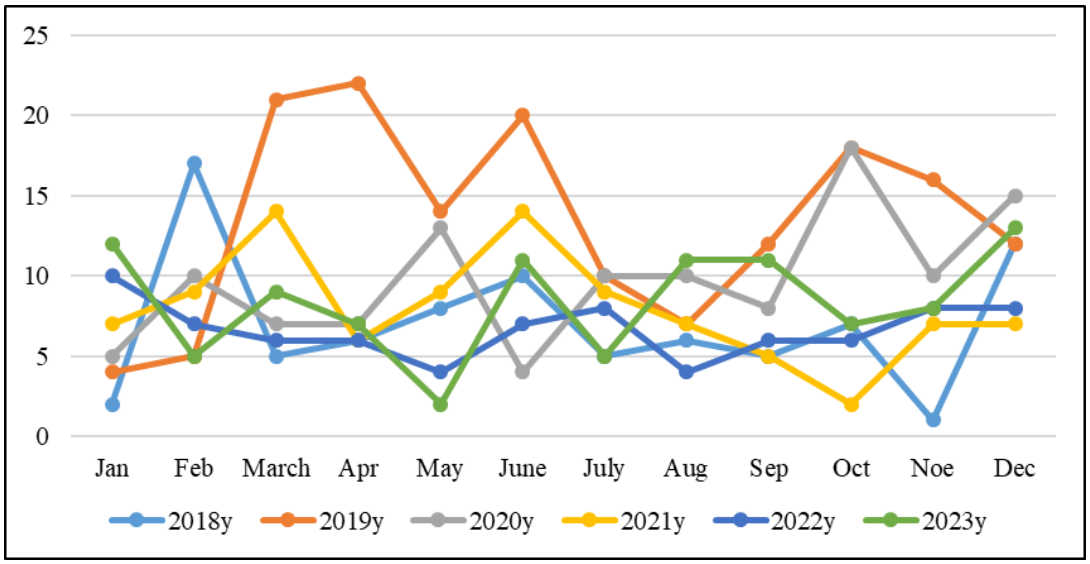

Figure 9. Rate of dog bites by months and years in the municipality of Centar.

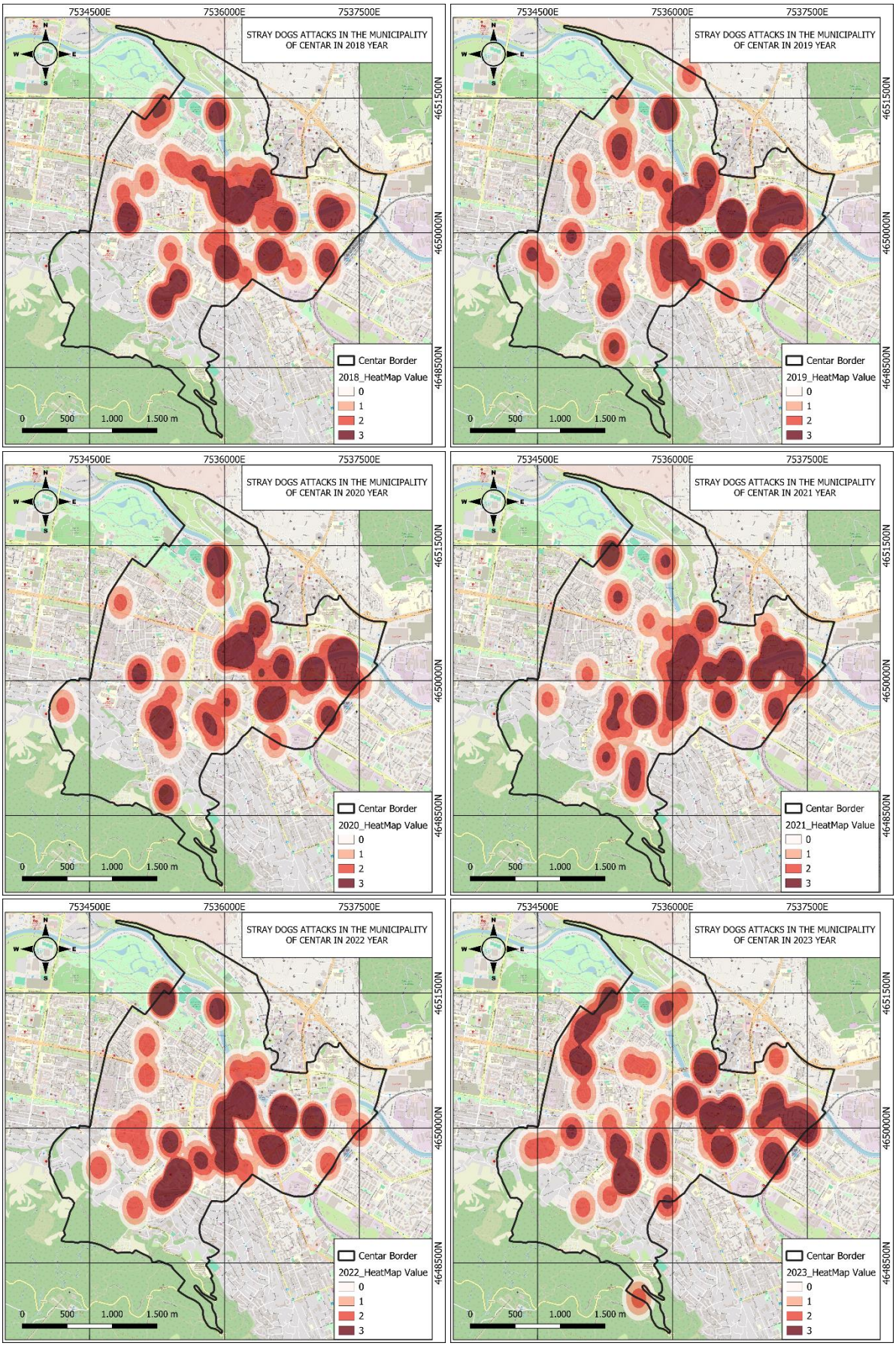

Figure 10. Spatial patterns of Heatmaps for dogs attack per year.

In 2020, there was a decrease in the number of reported cases of attacks by stray dogs, so a total of 117 cases were registered. During the month of October, 18 cases were reported, while the lowest number, a total of four bites, were reported in June. In 2021, the trend of reducing the number of bites by stray dogs continues, with a total of 96 cases reported, of which the most were reported in the months of March and June, 14 each, while only 2 bites were reported in October. The trend of decreasing attacks by stray dogs in the municipality of Centar continues in 2022, with 80 cases of bites reported. So, the most reported cases are in January (10 cases), while the lowest number of reported attacks are in May, with only two cases of bites by a stray dog. Also, 2022 is the year with the lowest number of reported cases in the period from 2018 to 2023, where the incidence rate is 18.23. In the following year, 2023, a slight increase in the number of attacks and bites was recorded, with a total of 101 bites from stray dogs reported to the Ministry of the Interior. The most reported cases were recorded in December (13 cases), while only two cases were reported in the month of May.

In terms of the spatial distribution of attacks by stray dogs, all attacks are in the urban part of the municipality, where the population is constantly moving. So, the most cases of attacks and bites by stray dogs is "Macedonia" Square with 71 reported cases, followed by the Vardar river quay path with 51 reported cases, then the "Mother Teresa" Clinic complex with 35 reported cases, Goce Delchev Boulevard with 17 reported cases, etc. According to the distribution of districts in the Municipality of Centar, the most cases are Centar-1 with 306 attacks, the second is the district of Madzir Maalo with 71 cases, the third is Novo Maalo with 47 cases, Krnjevo with 30 cases, Debar Maalo with 26 cases, the Kapishtec with 25 cases of bites, Prolet with 21 cases of bites from stray dogs, Kale with 20 cases, Tasino Chesmiche with 20 cases, Vodno with 12 cases, Bunjakovec with 9 cases of bites, Centar-2 with 6 cases and Panorama with 6 cases. The southeastern part of City Park which administratively belongs to the Municipality of Centar has total of 40 cases of stray dog attacks registered.

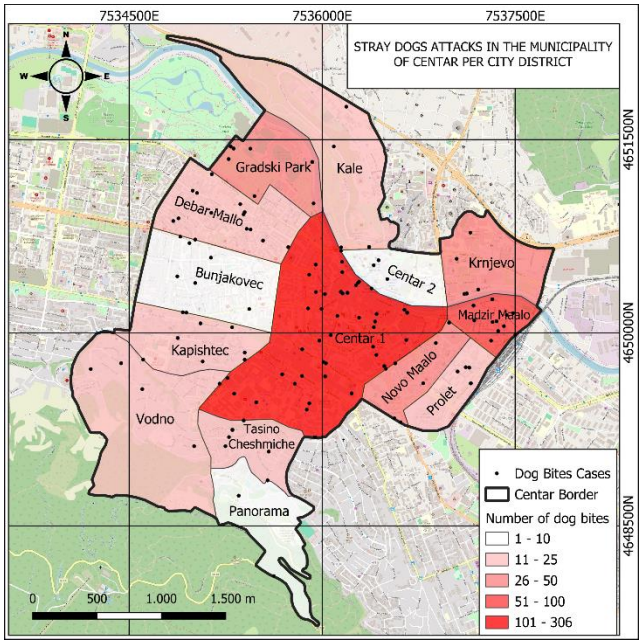

Figure 11. Stray dogs bites per city district in Municipality of Centar

DISCUSSION

Dogs are a part of human's life, and he interacts a lot with them. Dog bite injuries, especially from stray dogs, represent a significant public health problem that needs to be better studied in order to develop better strategies to improve the condition, mitigate the consequences for humans and dogs, and as follow-up of the situation and the population of vagrants in the Centar and in the neighboring municipalities of the territory of the City of Skopje. Out of 639 reported cases of dog bites, only 255, apart from having a record of the type of injury to the affected person, while in 384 registered cases, there is no such information. Also, no single fatalities has been reported as a result of stray dog attack. For comparison, in 2016 alone, in Europe 45 people died as a result of being bitten by a stray dog, while in the United States, between 2003 and 2017, a total of 433 people died from an attack by stray dogs (an average of 33 people per year) (Sarenbo & Seunson, 2021). There are approximately 250,000 reported cases of dog bites in the UK each year that require medical attention (Morgan & Palmer, 2007).

In the territory of the municipality of Centar, the total incidence rate is 145.58 per 10,000 inhabitants, while the average annual incidence rate is 24.26 per 10,000 inhabitants. The incidence of bites by stray dogs in Sicily had doubled in a decade, where the trend of significant increases in incidence is in men and women (Alberghina et al., 2023), while in Uruguay the incidence of bites is 87.51 per 100,000 persons (Roman et. al., 2023). In the period between 2004 and 2014, the incidence of dog bites in New Zealand was 11.3 per 100,000 inhabitants, i.e. 496 reported cases per year (Mair et al., 2019). In Kenya, however, there is a large variation, where the highest value is in 2018 with 433.6 cases per 100,000 inhabitants (Kung'u & Brodbelt, 2023).

According to the representation of children and minors, in the municipality of Centar, they represent only 9.07% of the reported attacks. However, in other countries, minors represent a significant number of dog bites, i.e. 32.3% (Alberghina et al., 2023). In Poland, in the period from 2006 to 2020, 23.8% of hospitalized persons from stray dog bites were children up to 9 years of age (Cianciara et al., 2022), while in Portugal, 34.2% of bitten cases from dogs are young people under 18 years old (Fragoso et al., 2022). In Bangladesh, people under the age of 20 represent 40% of all registered cases of bites (Alam et al., 2020), while in Kenya, the share of children under the age of 15 is 51% of the people bitten (Kung'u & Brodbelt, 2023).

Even though children and minors have a significant share in the total number of reported cases of bites from stray dogs in the Municipality of Centar, the largest represented group is people aged 18 to 64 with 520 bites (81.39% of cases). In the territory of Poland alone, 60% of reported cases are adults (Cianciara et al., 2022), while in Kenya, 49% of reported cases of bites are aged 16 and over (Kung'u & Brodbelt, 2023).

In terms of the representation of attacks in the seasons, in the territory of the municipality of Centar, they are evenly represented, i.e. no single time of year dominates the number of bites and attacks by stray dogs. But this is not the case in Uruguay (Roman et al., 2023), where the percentage of people bitten by stray dogs is higher in spring and summer. Similar results were published in the research in Spain (Rosado et. al., 2023), where most of the bitten people are registered in the summer period. In Kenya, the lowest number of stray dog bites are reported during the dry season, while the highest number of stray dog bites are recorded during the short rainy season in October-December (Kung'u & Brodbelt, 2023).

CONCLUSION

According to the analyzed data, we can determine that despite the number of aggression of stray dogs that varies over the years, they still represent a significant problem for the population in the Municipality of Centar. The municipality covers an area of 7.52 km^2 with a total population of 43,893 inhabitants. In the period from 2018 to 2023, a total of 639 attacks and bites from stray dogs were reported. Of these, 255 registered cases have a record of the type of injury, while in 384 registered cases, that information is missing. According to the representation of age groups, 9.07% are minors under the age of 18. Of them, 57% are male minors (33 reported cases), while 43% of those attacked are female (25 cases). People over 65 years of age are represented in 9.54% of all reported cases. According to the gender structure, 10 cases of injured persons are female (16.4%), while 51 cases of injured persons are male (83.6%). The population aged 18 to 30 is most represented with 162 bites (25.32% of cases), followed by the next group from 31 to 40 years old with 119 bites (18.62% of cases), and then the rest of age groups. From the total number of reported bitten persons, according to the gender structure, the male population significantly dominates with 407 reported cases (63.7%), while only 231 cases are from the female population (36.15%). In only one case, the gender of the person who was bitten by a stray dog was not specified. The male population is 1.76 times more represented in this statistics of bites, although the male population is 46.5% of the population in the Municipality of Centar. According to the representation of the gender structure, the incidence of bites in the female population is 98.28 per 10,000 inhabitants for the entire period of six researched years, while the male population incidence is 199.62 per 10,000 inhabitants. The average incidence rate in the studied six-year period is 145.58 per 10,000 inhabitants. Based on the time interval of attacks by stray dogs, overall, the most bites occurred in the period from 11:00 to 12:00 am, with a total of 86 attacks (13.45% of reported cases), while in the period from 05:00-06:00 am, not a single case was reported. In addition, according to the distribution of bites by day, there are 118 bites on Monday, 100 bites on Tuesday, 114 bites on Wednesday, 93 bites on Thursday, 78 bites on Friday, 76 bites on Saturday and only 60 bites on Sunday. According to the months, December has the most bites with 67 reported cases, followed by June with 66 reported cases and March with 62 reported cases. Months with the fewest bites are January with 40 reported cases and August with 45 reported cases. Based on the examined years, in 2018 84 cases were registered in the Centar, in 2019 there were 161 reported cases of stray dog bites, in 2020 there were 117 reported cases, in 2021 there were 96 registered cases, in 2022 there were 80 reported cases and in 2023 there were 101 cases. We can state that the daily, monthly and annual figures vary, and that they have no seasonal connection with the seasons. All the attacks took place in the urban part of the municipality, namely 71 reported cases on the "Macedonia" Square, then the path on the quay of the Vardar River with 51 reported cases, then the City Park with 40 bites from stray dogs, then the "Mother Teresa" clinic complex " with 35 reported cases, Boulevard Goce Delchev with 17 reported cases and etc.

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REMOTE DETECTION OF WATERFALLS AND CASCADES IN THE UPPER BASIN OF BASHIBOSKA RIVER USING DIGITAL MODELS AND AUTOMATED ALGORITHMS

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ABSTRACT

The upper basin of the Bashiboska River is situated on the southwestern slopes of the Belasica mountain, east of the town of Valandovo in the Republic of Macedonia. Bashiboska River is a continuation of Anska River, a left tributary of the Vardar River. The basin contains several waterfalls, including the renowned Kochuli Waterfalls. Until today, only the waterfalls near the Kochuli village are known due to the challenging terrain, leaving much of the upper basin unexplored. With the advancement of LiDAR technology, especially in creating high-resolution digital terrain models, remote sensing allows the discovery and registration of waterfalls. In our case, LiDAR data with a resolution of 1m x 1m was used, enabling the detection of areas where the river bed precipitously drops. For the detection of waterfalls, an automated process called "Model Builder" from the ArcGIS software package was used. It involved entering several predefined rules and criteria, leading to the detection of all potential locations of waterfalls. In our research, we identified 104 locations where waterfalls and cascades higher than 2m with a slope greater than 45° could be found. Among them, we can confirm with certainty that 12 locations have waterfalls, as they have been thoroughly investigated.

Keywords: Waterfall, cascade, digital terrain model, LiDAR, ArcGIS, Model Builder, Belasica, Republic of Macedonia

INTRODUCTION

A waterfall is defined as a steep, often vertical, rocky section of a river bed over which the flow of the river descends (Kolchakovski, 2006). Unlike a waterfall, a cascade is a steep drop in the river bed over which water falls in a stepped or cascading manner over several small rocky sections. Based on their formation, waterfalls and cascades can be classified as tectonic, erosive, and accumulative (Kolchakovski, 2006). Tectonic waterfalls occur at a fault between two tectonic blocks. Erosive waterfalls are formed through erosion, i.e., undercutting of the softer rocks found in the lower layers, over which more resistant rocks lie, then through vertical cutting of the main river in relation to its tributaries and by the main glacier in the trough valleys relative to the side valleys. Accumulative waterfalls are created in karst terrains where calcium carbonate (Limescale) deposits accumulate in the river beds (Kolchakovski, 2006). In the Republic of Macedonia, there are mostly tectonic and erosive waterfalls. The majority of tectonic waterfalls are found in the area of the Belasica mountain. Belasica is a classic example of a horst morphostructure formed by a series of contrasting faults (Kolchakovski, 2022). Hence, it is not

coincidental that some of the most famous waterfalls in the Republic of Macedonia are located on this mountain, such as: Smolari Waterfalls, Koleshino Waterfalls, Gabrovo Waterfalls, Kochuli Waterfalls, etc.

Although a large number of waterfalls have been explored in the Republic of Macedonia, there are still hard-to-reach and inaccessible locations where new waterfalls can be found and discovered. In recent years, technological advancements have made it possible to register waterfalls on various satellite images and digital models. In this context, drones can be used as a means of waterfall detection, allowing waterfalls to be seen and photographed from heights inaccessible to humans. The process of remote detection of waterfalls has been accelerated by the creation of high-resolution digital models capable of detecting even the smallest drop in the river bed, thereby registering all locations where waterfalls and cascades exist. Examples of waterfall detection using digital models and satellite images are provided by Alexey V. Kutuzov from the Russian Academy of Sciences, who explored the areas of the high-mountainous Jinbar waterfall and the low-mountainous waterfalls of the Blue Nile River in Ethiopia (Kutuzov, 2021). The same author used topographic maps, SRTM, Aster GDEM and ETOPO2 digital models, as well as satellite images from the Sentinel-2 program. Similar examples of waterfall detection are mentioned by adventurers and GIS experts Christopher Ryan Cockfield and Mark Oleg Ozboyd from the USA, who use LiDAR digital models and high-resolution data (1m x 1m) as a means of waterfall detection. Christopher Ryan Cockfield focuses on the state of South Carolina (https://waterfalladventurer.weebly.com/lidar.html), while Mark Oleg Ozboyd explores the state of Georgia (Ozboyd, 2024).

In the Republic of Macedonia, the path for remote detection of waterfalls is being paved by the Agency for Real Estate Cadastre, which conducted LiDAR surveys of the territory of Republic of Macedonia with the support of the Norwegian Mapping Authority – NMA (Jakir et al., 2022). The LiDAR surveying was carried out between 2019 and 2022, completed in two phases. The first phase was conducted by the MGGP AERO company from Poland, and the second phase was carried out by the PRIMUL MERIDIAN company from Romania. During the first phase, the Riegl VQ-780i laser standard was used, flying at a height of 1450m above the ground. The second phase was recorded with the Riegl VQ-1560i laser standard, flying at 2585m above the ground (MGGPAERO, 2019). The products from the LiDAR recordings have a resolution of 1m x 1m. During their processing, two types of LiDAR specifications were used: LiDAR B with a density of 5 points per m^2 and LiDAR C with a density of 2 points per m^2. The processing of LiDAR data produced a cloud of points (Point of Cloud) in LAZ and zLAS formats, as well as a digital terrain model (DTM) and a digital surface model (DSM). These LiDAR data have a vertical accuracy of ±0.10m, while the tolerance for horizontal accuracy is ±0.30m (AGENCY FOR REAL ESTATE CADASTRE, 2018).

STUDY AREA

The upper basin of the Bashiboska River is located on the southwestern slopes of the Belasica mountain. The basin stretches between the peak of Unka Tepe in the east, the ridge of Bajrambos in the south, the peak of Tarla Bash in the west, and the northwestern Belasica ridge in the north (Dzilvidziev, 2015). The easternmost point of the upper basin of the Bashiboska

River is the peak of Unka Tepe (1368 m), while the westernmost point is near the peak of Korubash (353 m). The northernmost point is near the peak of Dzami Kran (1198 m), while the southernmost point is the confluence of the Elez Dere river into the Bashiboska River. The distance between the easternmost and westernmost points is 7.52 km, while the distance between the northernmost and southernmost points is 6.38 km. The highest point in the upper basin of the Bashiboska River is the peak of Unka Tepe (1368 m), and the lowest point is the confluence of Elez Dere into the Bashiboska River (235 m). The elevation difference between these two points is 1133 m. Within the previously described boundaries, the upper basin of the Bashiboska River covers an area of 21.36 km². The basin consists of 46 constant and periodic rivers. Of these, 14 rivers are longer than 1 km, and 7 rivers extend more than 2 km. The longest watercourse is the Bashiboska River (2.8 km) – Kaldrma Dere (7.72 km) with a total length of 10.52 km.

Table 1. Hydrographic characteristics of the largest watercourses in the upper basin of Bashiboska River.

RIVER	Bashiboska River	Kaldrma Dere	Ark Dere	Chamdash Dere	Bashiboska River – Kaldrma Dere
Left/right tributary	/	/	Right	Right	/
Constant/periodic watercourse	Constant	Constant	Periodic	Constant	Constant
Stream order (Strahler)	5	4	4	4	5
First point (m)	363	1280	925	1199	1280
Last point (m)	235	363	328	363	235
Total decline (m)	128	917	597	836	1045
Average decline (m/km)	45.7	118.3	120.1	132	99.3
Length (km)	2.80	7.72	4.97	6.33	10.52
Minimum Length (km)	1.97	5.17	3.92	4.42	7.02
Basin Area (km²)	1.99	6.53	6.12	6.72	21.35
Total Watercourses in Basin	5	15	15	11	46

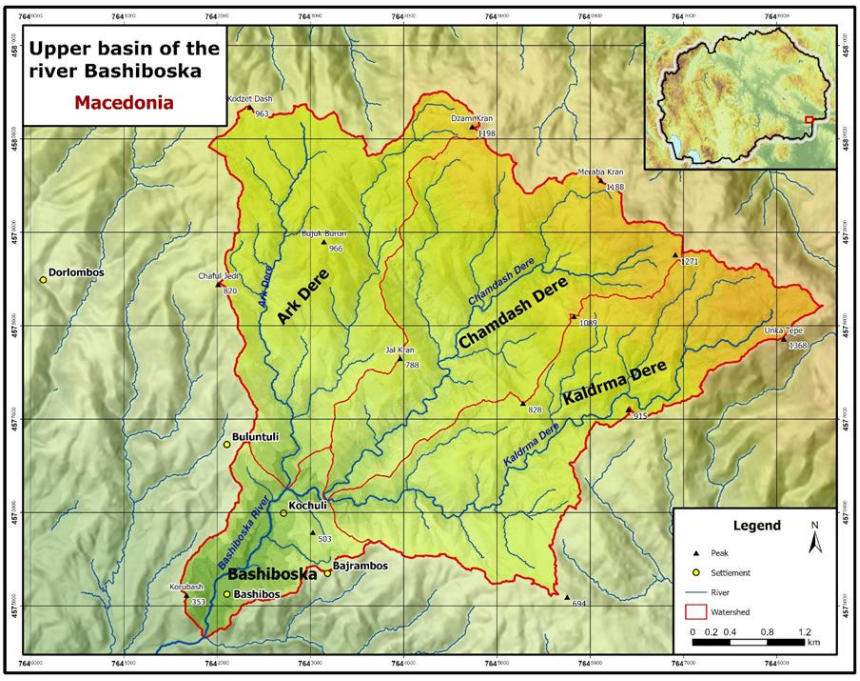

Figure 1. Geographic position of the upper basin of Bashiboska River

MATERIALS AND METHODS

This study includes LiDAR data obtained from the LiDAR portal of the Agency for Real Estate Cadastre (AREC). In this context, data in the format of a Digital Terrain Model (DTM) with a resolution of 1 meter were used. These data enable conversions that show elevation, a shaded model of the Earth (Hillshade), and a slope model. With the help of these converted data, it is easy to observe the decline in the river bed, thereby detecting potential waterfalls and cascades.

For the purposes of this research, the ArcGIS software package with desktop applications ArcMap and ArcGIS Pro was used. With these software tools, conversions of DTM data were performed and more relevant data were obtained, such as: points with elevation, points with slope, basins with area, and rivers with stream order and length. All these data were used as input parameters in an automated process called "Model Builder". Model Builder is a powerful tool that allows for the execution of multiple predefined analyses and automated processes at once. In this context, a Model Builder was created in the ArcGIS Pro software package, which automatically detected all potential waterfalls and cascades in the upper basin of the Bashiboska River. Before the analysis and detection of waterfalls and cascades were carried out, a set of detection rules was created. This set contains several rules, including restrictions regarding the points with slope and elevation and their intersection with watercourses, rules on rivers including stream order, length, and basin area. In the detection rulebook integrated into the automated Model Builder process, rivers with a stream order of second category and higher were included, as well as all rivers longer than 500 meters, and with a larger basin area than 0.5 km^2. Furthermore, the detection rulebook included a rule to detect all locations intersecting with the river bed, having a height greater than 2 meters, and a slope greater than 45 degrees. In this way, all potential waterfalls and cascades were detected, which were then manually verified with the elevation and slope data, removing any results that deviated from the river beds of the watercourses.

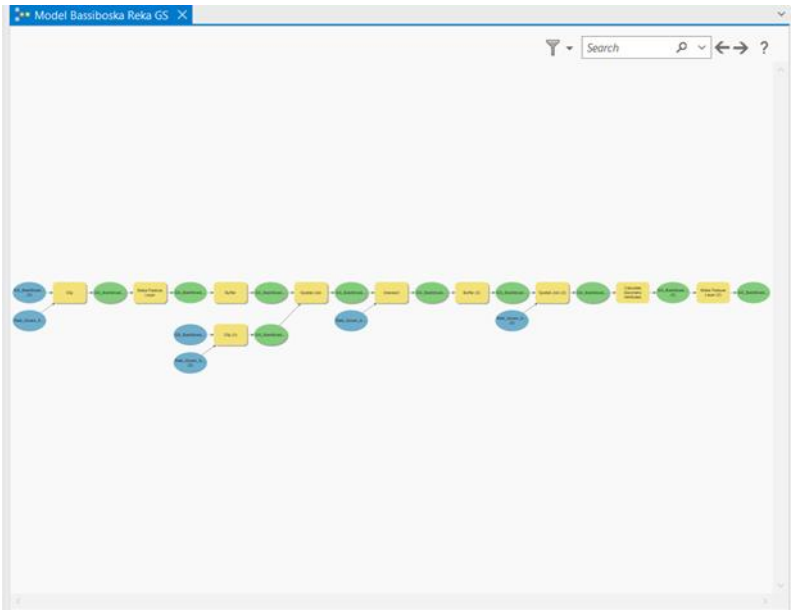

Figure 2. Visual representation of the automated Model Builder process, with blue marking the input data, yellow indicating the tools used, and green representing the output data, i.e., the results

RESULTS

With the aid of the automated Model Builder process and all previously defined procedures, 166 polygons (locations) representing potential waterfalls and cascades were identified. These locations were manually verified using maps with contour lines, hillshade and slope models, which led to the identification of two types of errors: polygons that are part of a single waterfall or cascade but do not intersect, and polygons that are vertical sections along the banks of watercourses without a direct decline in the river bed. After correcting the aforementioned errors, the number of potential waterfalls and cascades was reduced to 101 locations. Further examination of the river valleys identified an additional 3 locations not registered by the automated Model Builder process, yet meeting the criteria for potential waterfalls and cascades according to the predefined rules. Thus, a total of 104 locations where waterfalls and cascades might be found were registered in the upper basin of the Bashiboska River.

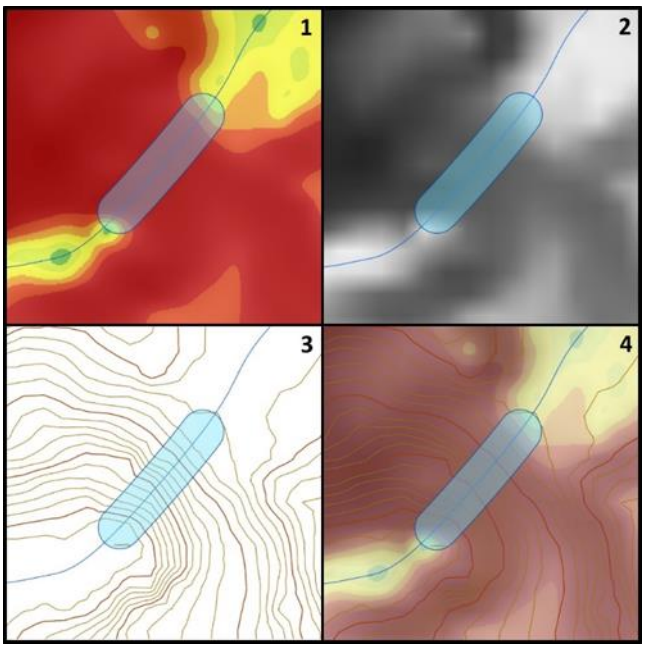

Figure 3. Detection of waterfalls using a digital slope model – Slope (1), digital shaded model – Hillshade (2), contour lines model (3), and a combined model of contour lines, digital hillshade and digital slope model (4).

Similar methods for remote detection of waterfalls are used by Christopher Ryan Cockfield and Mark Oleg Ozboyd from the USA, who detect waterfalls using high-resolution LiDAR data of 1m x 1m. These researchers convert LiDAR data to obtain a digital hillshade model, digital slope model, and a contour line model. Combining these methods, Christopher Ryan Cockfield in South Carolina (USA) detected over 300 waterfalls higher than 2m (https://waterfalladventurer.weebly.com/lidar.html), while Mark Oleg Ozboyd in Georgia (USA) detected over 500 waterfalls higher than 2 meters (Ozboyd, 2024). Both researchers and GIS experts indicate that using a combination of these three models is necessary to avoid false detection. Christopher Ryan Cockfield mentions that sometimes remote detection with LiDAR data can be incorrect. He notes an instance where digital analysis suggested a waterfall 12 m in height, which did not exist in reality (https://waterfalladventurer.weebly.com/lidar.html). One of the main reasons

for obtaining incorrect results, according to this author, is the presence of small gorges or narrow beds with high vertical banks, where LiDAR technology may fail to provide accurate data (https://waterfalladventurer.weebly.com/lidar.html). Nonetheless, Christopher Ryan Cockfield claims that LiDAR technology is a significantly better method for remote detection of waterfalls compared to traditional methods and the use of topographic maps.

Unlike previous authors, Alexey V. Kutuzov uses several examples for the detection of waterfalls, such as: satellite images from EarthExplorer and Sentinel-2 programs (10 m/pixel resolution), slope models obtained from SRTM and Aster GDEM and topographic maps. With the help of satellite images, Alexey V. Kutuzov detects all the bright surfaces that are located in the river beds that represent waterfalls and rapids. Also, this author uses slope models with which he notes all the slopes of the river bed that deviate and have a large drop.

Previously, the waterfalls in the upper basin of the Bashiboska River or Kochulski waterfalls were explored by Dzilvidziev G. and Stojcheski D., who during field research in the lower course of the Ark Dere, Chamdash Dere, and Kaldrma Dere stream recorded 14 waterfalls and cascades higher than 2 meters. With the automated Model Builder process for detecting waterfalls, as well as with the aid of LiDAR data, 12 waterfalls were registered, matching the waterfalls previously explored in the field. The detection did not include only two small cascades which, according to field measurements, are 2 to 3 meters in height and do not meet the slope criterion, i.e., they have a slope less than 45°.

Table 2. Overview of waterfalls previously recorded in the field, compared to the results obtained with LiDAR data through the automated Model Builder process

Waterfall	River	Top Elevation (amsl)	Bottom Elevation (amsl)	Height (m)	Average Length Top-Bottom (m)	Length of Longitudinal Profile – Field Measurements (m)
Akr Dere – 2	Akr Dere	428.31	422.65	5.66	8.03	7
Akr Dere – 3	Akr Dere	450.96	441.33	9.63	12.2	13.5
Akr Dere – 5	Akr Dere	505.99	496.68	9.31	9.78	9
Akr Dere – 8	Akr Dere	531.54	520.98	10.56	14.54	10.5
Akr Dere – 9	Akr Dere	549.73	536.44	13.29	18	13
Chamdash Dere – 1	Chamdash Dere	487.73	485.48	2.25	4.58	3.5
Chamdash Dere – 2	Chamdash Dere	511.28	505.16	6.12	9.14	10
Chamdash Dere – 3	Chamdash Dere	532.75	522.17	10.58	15.33	10
Chamdash Dere – 4	Chamdash Dere	547.96	543.22	4.74	5.83	6
Kaldrma Dere – 1	Kaldrma Dere	407.18	403.75	3.43	8.47	10.5
Kaldrma Dere – 2	Kaldrma Dere	422.62	408.01	14.61	15.97	17
Kaldrma Dere - 3	Kaldrma Dere	426.59	423.74	2.85	5.75	5

It is important to note that during 2015, Dzilvidziev and Stojcheski measured the length of the longitudinal profile of the waterfalls in the field. Table 2 provides a comparison of these field measurements against those obtained from LiDAR data with a 1-meter resolution. For most of the waterfalls, deviations of ±1 meter in the length of the longitudinal profile compared to the average length can be observed.

In this study, besides the location of the waterfalls obtained digitally, the following data were also gathered: coordinates of the waterfall, elevation at the top of the waterfall, elevation

at the bottom of the waterfall, height of the waterfall, average length of the waterfall, maximum slope, and average slope of the waterfall. The height of the waterfall was determined by the difference between the elevation at the top and the bottom of the waterfall. The average length was calculated using the 3D distance between the top and bottom elevations, while the distance was calculated using the Pythagorean theorem ($a^2+b^2=c^2$), where "a" represents the height, "b" represents the horizontal (shortest) distance between the top and bottom elevations of the waterfall, and side "c" is the average length of the waterfall. The maximum slope of the waterfall was obtained from the automated "Model Builder" process, while the average slope was calculated using the mathematical formula:

$$\angle\alpha = \arcsin(\frac{a}{c})$$

Where "$\angle\alpha$" represents the angle, i.e., the slope of elevation of side "c" in relation to side "b", which is a horizontal line.

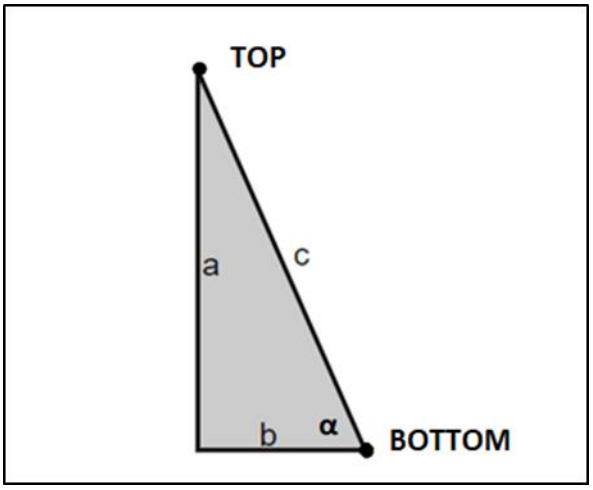

Figure 4. Shows the method for calculating the dimensions (sides) of a waterfall, where: side "a" is the height of the waterfall; side "b" is the shortest horizontal distance between the top and bottom elevations of the waterfall; side "c" is the average length of the waterfall; and the angle α represents the average slope of the waterfall.

Waterfalls and cascades identified using 1m DTM LiDAR data can be divided into four height categories: waterfalls under 5 meters (2-5 meters), waterfalls from 5 to 10 meters, waterfalls from 10 to 15 meters and waterfalls over 15 meters. There are 59 waterfalls in the first group of waterfalls up to 5 meters, accounting for 56.73% of the potential waterfall and cascade locations. The second group, from 5 to 10 meters, consists of 31 locations with potential waterfalls and cascades. The third group, with waterfalls ranging from 10 to 15 meters in height, includes 11 potential waterfalls and cascades. In the last group, or the group of waterfalls higher than 15 meters, there are 3 potential waterfalls and cascades. According to the height, the highest waterfall recorded in the upper basin of the Bashiboska River is the location "KD-P2-3" or waterfall 3 from tributary 2 of the Kaldrma Dere river, which is approximately 24 meters high according to LiDAR 1m DTM.

Regarding the slope, all locations (waterfalls) where the maximum slope exceeds 45° have been registered. Based on the slope, the locations of potential waterfalls and cascades are categorized into three groups: waterfalls with a slope of 45° to 55°, waterfalls with a slope of 55° to 65°, and waterfalls with a slope greater than 65°. The first group (45°- 55°) consists of 64 waterfalls and cascades. The second group (55°- 65°) includes 28 waterfalls, while the third group has 12 waterfalls with a slope greater than 65°. The absolute steepest slope was observed at the waterfall "Ark Dere-8" or Waterfall 8 on the Ark Dere river, which has a slope of 75° according to LiDAR data.

Regarding the hypsometry, there is a varied distribution of waterfalls. Five hypsometric zones have been identified: 400-600, 600-800, 800-1000, 1000-1200, and above 1200 meters. Most waterfalls are registered in the elevation zone from 400 to 600 meters, and only 3 waterfalls are located at an altitude greater than 1200 meters.

Table 3. Overview of waterfalls by hypsometric (elevation) zone

Elevation Zone (amsl)	400 - 600	600 - 800	800 - 1000	1000 - 1200	Over 1200
Number of waterfalls	34	18	23	26	3

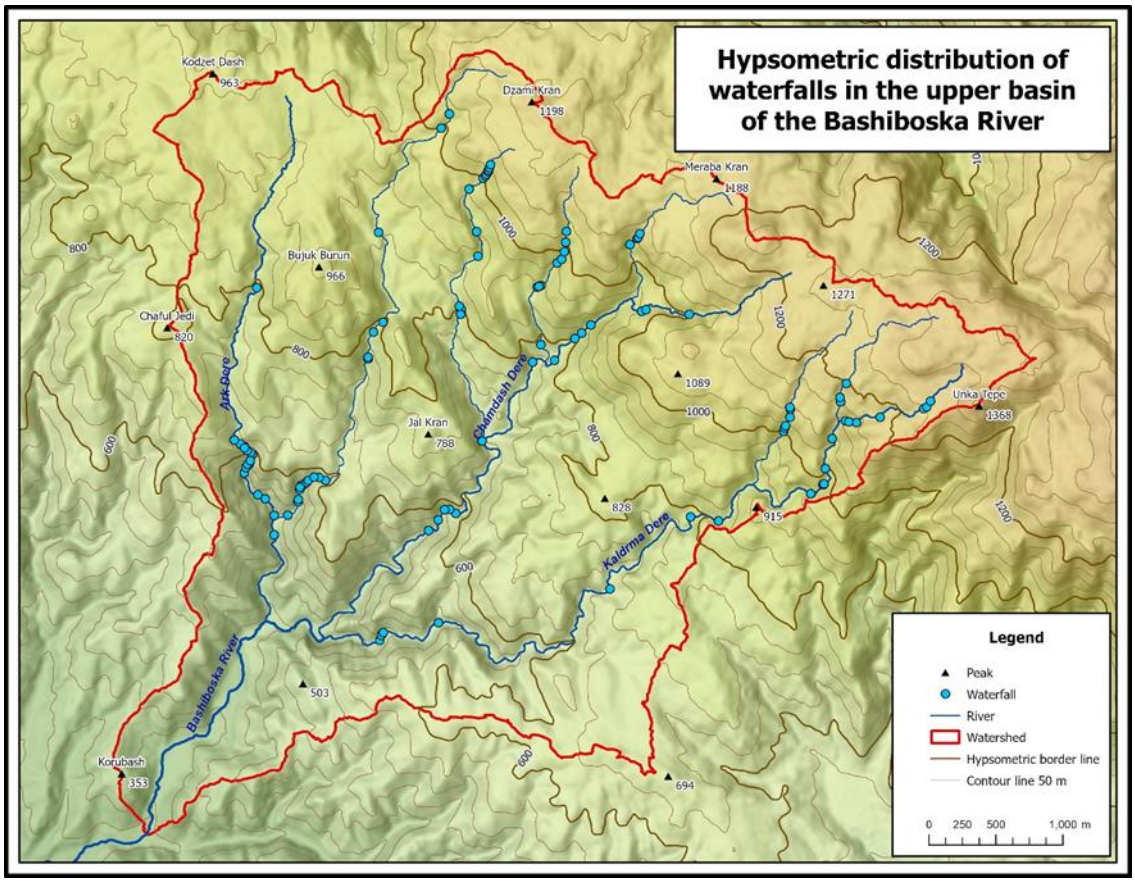

Figure 5. Hypsometric distribution of waterfalls in the upper basin of the Bashiboska River.

Among the river basins, the highest number of waterfalls is observed in the basin of the Chamdash Dere river (40 waterfalls), followed by Ark Dere (36 waterfalls) and Kaldrma Dere (28 waterfalls). Regarding larger watercourses, the Kaldrma Dere river has the most waterfalls and

cascades (19 waterfalls and cascades), along with the Galash Jedi Dere, i.e., tributary 9 from the Ark Dere basin (19 waterfalls and cascades).

Table 4. Waterfalls and cascades according to the river and river basin.

River	Number of waterfalls	Total waterfalls in the basin
Ark Dere	17	36
Galash Jedi Dere (tributary 9 of the Arc Dere)	19	/
Chamdash Dere	14	40
Chamdash Dere - (tributary 4)	4	/
Chamdash Dere - (tributary 5)	9	/
Chamdash Dere - (tributary 7)	13	/
Kaldrma Dere	19	28
Kaldrma Dere - (tributary 1)	3	/
Kaldrma Dere - (tributary 2)	6	/

The highest waterfall in the Ark Dere river basin is "Waterfall 8" (AD-T9-8), located on the Galash Jedi Dere river (tributary 8 of Ark Dere). According to LiDAR data and analyses, this waterfall has a height of 13.59 m. In the Ark Dere basin, the most famous and attractive waterfall is the Kazan Waterfall (Ark Dere -3), which is 9.6 m high. This waterfall is known for its whirlpool or giant pot resembling a cauldron, from which the waterfall's name is derived.

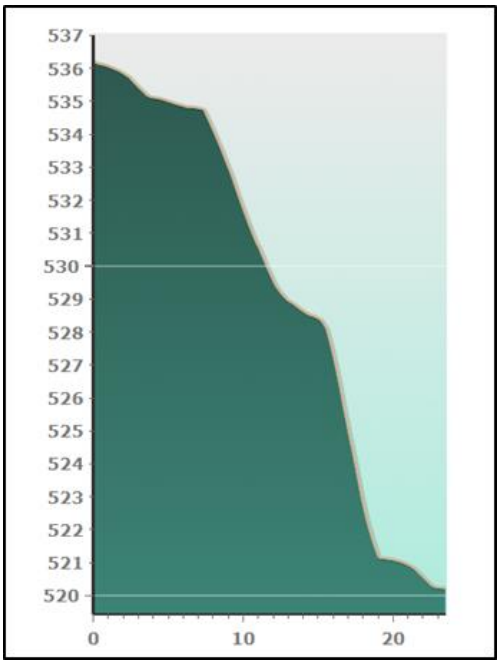

Figure 6. Profile of Galash Jedi Dere Waterfall 8 (AD-P9-8)

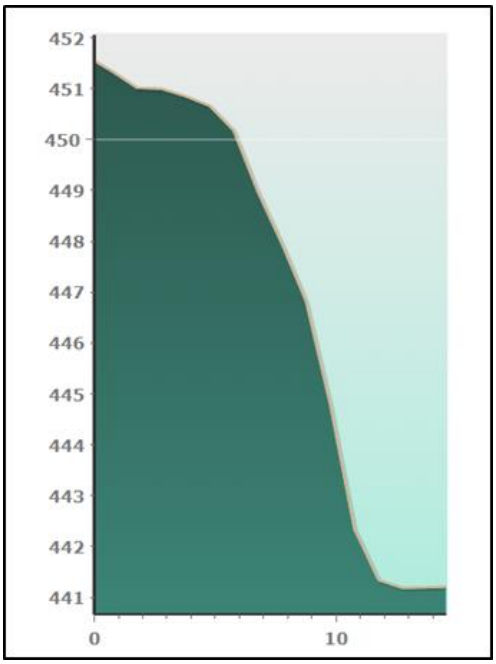

Figure 7. Profile of Kazan Waterfall (Ark Dere 3)



Figure 8. Kazan Waterfall (Ark Dere 3)



Figure 9. 3D Profile of Kazan Waterfall

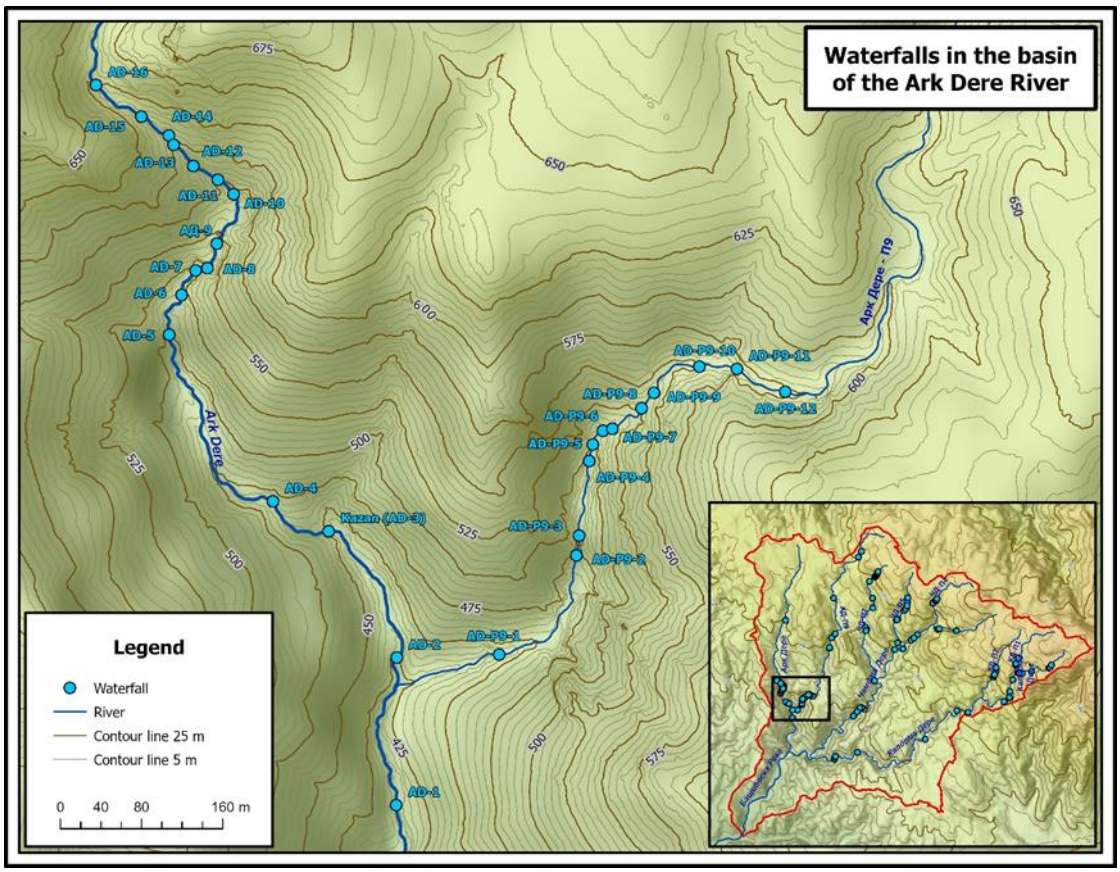

Figure 10. Display of waterfalls and cascades in the lower basin of the Ark Dere River

In the basin of Chamdash Dere river, 40 waterfalls and cascades have been detected. The highest waterfall is Waterfall 9 (CD-T7-9) located on tributary 7 of the Chamdash Dere basin. According to LiDAR 1m DTM, this waterfall is 15.5 m high. So far, 5 waterfalls and cascades have been recorded and confirmed in the field within the Chamdash Dere basin. Of these, the

"Zavesa" (“Curtain”) Waterfall (Chamdash Dere 3) standing at 6.1 m and the “Razigran” ("Playful") Waterfall or Chamdash Dere 3, which is 10.5 m high, are particularly attractive.

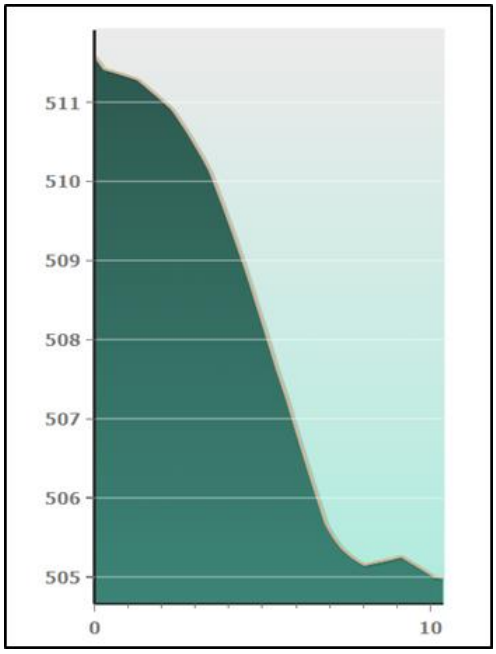

Figure 11. Profile of the "Zavesa Waterfall (Chamdash Dere 2)

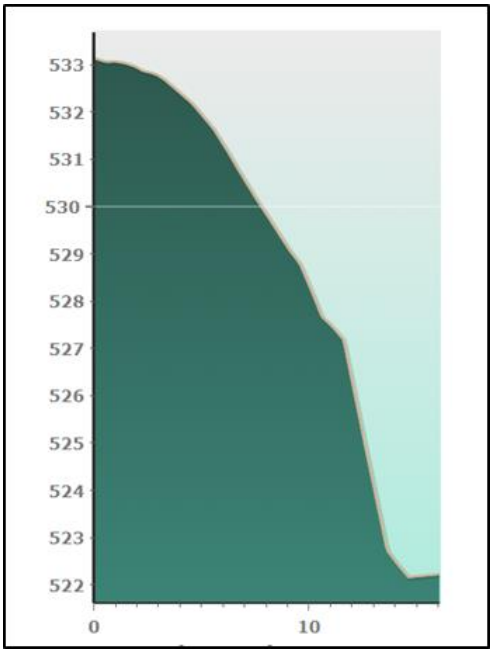

Figure 12. Profile of the "Razigran" Waterfall (Chamdash Dere 3)



Figure 13. The "Zavesa" Waterfall



Figure 14. The "Razigran" Waterfall

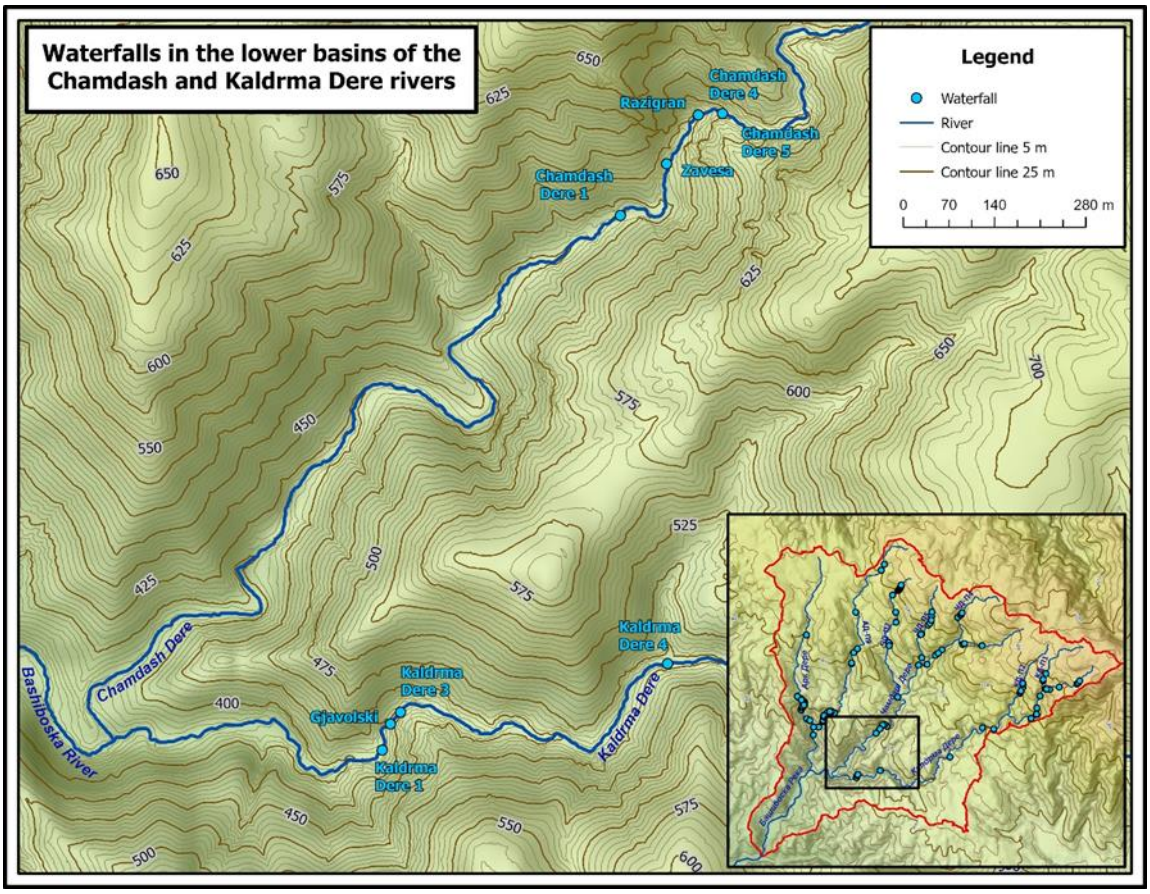

Figure 15. . Display of waterfalls and cascades in the lower basins of the Chamdash and Kaldrma Dere rivers

According to the results obtained from the detection using LiDAR 1m DTM, fewer waterfalls are observed in the Kaldrma Dere basin compared to the other two basins. The highest waterfall in this basin is "Waterfall 2" from tributary 2 of Kaldrma Dere, referred to in the study as "KD-T2-2." This waterfall has a height of 24.2 m. In the Kaldrma Dere basin, only three waterfalls located in the lower basin of the river have been explored in the field. The most attractive and famous waterfall in this basin, and indeed in the entire Bashiboska River basin, is the Gjavolski (Devil's) Waterfall, also known as the Kochulski Waterfall or Kaldrma Dere 2. This waterfall has a height of 14.6 m, and its profile shows a drop of 71.26°.

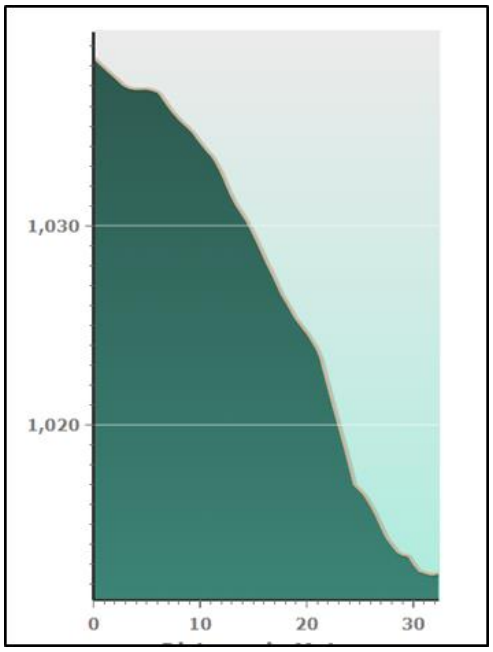

Figure 16. Waterfall 2" from tributary 2 of Kaldrma Dere (KD-T2-2)

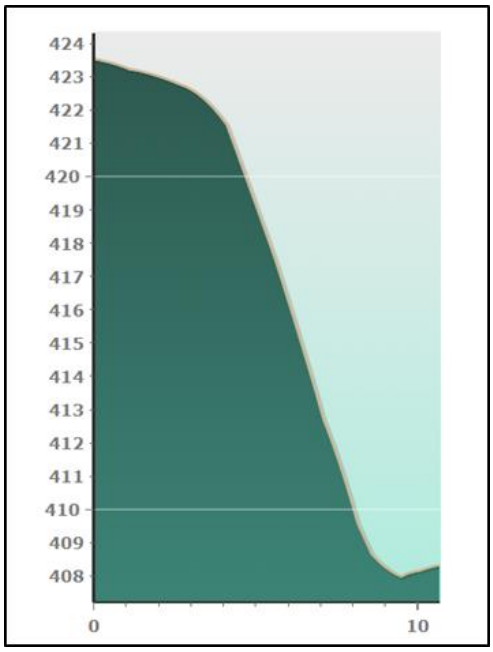

Figure 17. Figure 17. Profile of the Glavolski Waterfall or Kochulski Waterfall (Kaldrma Dere 2)



Figure 18. Gjavolski Waterfall



Figure 19. 3D Profile of the Gjavolski Waterfall

CONCLUSION

The upper basin of the Bashiboska River, situated on the southwestern slopes of the Belasica mountain, encompasses 46 constant and periodic rivers. Of these, 14 rivers are longer than 1 km, and 7 rivers extend more than 2 km. The longest watercourse is the Bashiboska River (2.8 km) – Kaldrma Dere (7.72 km) with a total length of 10.52 km. In 2015, the waterfalls of the Bashiboska River, or the Kochulski waterfalls, were explored by Dzilvidziev G. and Stojcheski

D., who recorded 14 waterfalls and cascades higher than 2 meters during field research in the lower course of the Ark Dere, Chamdash Dere, and Kaldrma Dere rivers. With the development of LiDAR technology and high-resolution digital models, the detection and discovery of waterfalls via remote detection have been enabled. For the purposes of this study, an automated process in ArcGIS Pro software called Model Builder was developed and applied. Using this process, which incorporated data from 1m LiDAR DTM, all river bed locations with a drop greater than 2 meters and a slope greater than 45° were detected. Following the automated Model Builder process, a manual digital check was performed to eliminate any potential errors, resulting in 104 locations where waterfalls and cascades could be found. The digital detection confirmed 12 of the previously explored waterfalls and cascades. The detection did not include only two cascades from field research that have a slope less than 45°. According to the basin, the most waterfalls were registered in the basins of the Chamdash Dere river (40 waterfalls), Ark Dere (36 waterfalls), and Kaldrma Dere (28 waterfalls). According to 1m LiDAR DTM, the tallest waterfall in the upper basin of the Bashiboska River is "Waterfall 2" from tributary 2 of Kaldrma Dere, referred to in the study as "KD-T2-2", with a height of 24.2 meters.

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ANALYSIS OF SPATIAL PLANNING AND GREEN INFRASTRUCTURE AT THE LOCAL LEVEL IN THE AREA OF JABLANICA AND RECOMMENDATIONS FOR THEIR IMPROVEMENT

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ABSTRACT

The area of Mount Jablanica, which is the subject of analysis in this paper, is of national importance. In addition to it, Mount Jablanica also has international importance as part of the Balkan Green Belt, i.e. as part of the European Green Belt. The areas along the Balkan Green Belt in North Macedonia and the area of Jablanica are under great pressure from humans, mainly due to intensive land use and infrastructural development. Also, so far little has been done to implement the concept of green infrastructure (GI) in the existing planning activity in the country, as well as at the local level in the pilot area. There is also a need to improve spatial planning legislation and practices and the relevant decision-making processes related to spatial planning. Using a qualitative research approach, this paper aims to review and analyze the spatial planning practice at the national and local level in the pilot area of Jablanica, the involvement of GI in spatial planning and its implementation, as well as to give some recommendations for their improvement.

Keywords: spatial planning, green infrastructure, planning documents, Jablanica

INTRODUCTION

The different interests and the different types of activities of the various stakeholders in the usage of the space and resources that belong to all of us often lead to overlapping interests and conflicts. Therefore, it is necessary to balance the different interests and ways of using the land, taking into account economic, social, and environmental aspects. The basic task of spatial planning is the promotion of long-term and sustainable socio-economic development and prevention and control of its harmful impact on the environment, in order to establish a balance between available space, economic and demographic development, and natural and cultural resources. Planning theory is a broad field of knowledge about which many scholars have written extensively (Allmendinger, 2017; Faludi, 2013; Healey, 2003). Planning theory has developed and changed dramatically over the short history of its existence (Hartmann and Geertman, 2016). In recent literature, one of the concepts that scientists are debating and trying to integrate into spatial planning is the GI concept. According to Mell (2010, p. 93) "GI, like all contemporary planning concepts, needs to engage with the structures of policy development if it is to be mainstreamed".

The development of better places to live, work and recreate can be achieved through GI planning (Mell, 2010). Throughout the literature, it can be noted that several authors debating GI have considered it as a redevelopment of existing concepts related to green space planning. However, the GI concept/approach differs from conventional land use/spatial planning approaches as it considers the multiple functions and benefits of green spaces in line with land development, growth management and built infrastructure planning. Within the scientific literature, it is suggested that GI infrastructure can include national parks, local nature reserves, gardens, etc. Namely, GI is defined as "an interconnected network of green spaces that conserves natural ecosystems values and functions and provides associated benefits to human populations. GI is the ecological framework needed for environmental, social and economic sustainability" (Benedict and McMahon, 2002, p. 12). Davies et al. (2006) state that, to effectively plan green infrastructure, professionals are required to have a conceptual understanding of environmental systems, knowledge of multi-functionality as it applies to green areas and an understanding of how environmental, economic and social issues intermingle in relation to sustainable communities and sustainable development agendas (quoted in Mell, 2010, p. 79). GI planning must be seen as of equal importance as other infrastructure to aid long-term sustainable planning (Benedict and McMahon, 2006; quoted in Mell, 2010, p. 80).

Due to the specific physical-geographic characteristics, the significant natural and cultural values and the rich biodiversity, but also due to the danger of degradation of the space due to the granting of concessions for the exploitation of mineral resources, there is an initiative to declare part of Jablanica a protected area in the category of a national park. It is particularly important that the Jablanica – Shebenik mountain massif already has the status of a national park in Albania (declared in 2012), so by declaring the Macedonian part of Jablanica Mountain a national park, a cross-border protected area would be established. On the other hand, so far little has been done to implement the GI concept in the existing planning activity in the country, as well as in the pilot area of Jablanica. Therefore, the current paper aims to analyze spatial planning practice at the national and local level in the pilot area of Jablanica, the involvement of GI in spatial planning and its implementation, as well as to give some recommendations for their improvement.

The remainder of the paper is organized as follows. The second section presents the research methodology. In the third part of the paper, coverage of the pilot area with planning documents is given. The fourth section shows the way of spatial planning at the national and local level. In the fifth part, the legal regulations affecting spatial planning and land use are analyzed. The sixth section elaborates on the Procedures for the development and adoption of the spatial plans and the plans for the management of protected areas and their planning horizons/validity. The next (seventh) section of the paper describes the cooperation of municipalities with the responsible institutions and participation of the public in the planning process and development of planning documents at a local level. The paper ends with a discussion, conclusion and some recommendations for the authorities.

METHODOLOGY

The methodology of the research process is divided into two phases. In the first phase of the research which involves data collection and processing, contact was made with all the relevant stakeholders in spatial planning, nature protection, and the management of protected areas on a national and local level (the Ministry of Environment and Spatial Planning – the Department for Spatial Planning, the Department for Nature, the Spatial Planning Agency, the Municipality of Struga, the Municipality of Vevchani, Public Enterprise National Park "Galichica"), during which all the relevant documents (laws and by-laws, plans at the national, regional and local level, strategies, programs) were obtained. In the second phase, a qualitative analysis of the collected documentation was made and the findings of this research were presented.

COVERAGE OF THE PILOT AREA WITH PLANNING DOCUMENTS

Based on the investigation and analysis of the space, it can be concluded that several types of planning documents play an important role in the planning and usage of the space of the target area, which are hierarchically related and can generally be divided into:

- Planning documents that refer to the entire territory of the country and are of exceptional importance for the spatial planning of the target area;
- Planning documents that refer to the region that the area belongs to;
- Planning documents that refer to the municipalities, and
- Planning documents at a local level, such as urban plans and different types of urban documentation.

Vertical and horizontal integration of the planning documentation

In order to establish connections, that is, to determine touchpoints of the pilot area with relevant national, regional, and local planning and strategic documents, vertical and horizontal alignment and coordination of acquired strategies and documents with the overall area are made.

Vertical interrelation with the relevant national and regional planning and strategic documents

Relevant documents that affect the planning and usage of the space within the boundaries of the pilot area:

- Spatial plan of the Republic of Macedonia (2004-2020);
- Spatial plan of the Ohrid-Prespa region (2005-2020);
- Regional plan for the Ohrid-Prespa region (1973-1993);
- Regional spatial plan covering the municipalities of Debar, Struga, Ohrid and Resen (1988) (in accordance with the administrative division of that time, today's Municipality of Vevchani belonged to the Municipality of Struga);
- Program for the development of the South-West planning region (2021-2026);
- National strategy for sustainable development (2009-2030);
- Strategy of regional development for the Republic of Macedonia (2009-2019);

- Strategy for balanced regional development of the Republic of North Macedonia (2021-2031);
- Strategy for agricultural and rural development for the period of 2014-2020;
- National strategy for the development of culture in the Republic of Macedonia (2018-2022);
- National strategy for tourism – Republic of Macedonia (2016-2021);
- National strategy for the protection of nature (2017-2027);
- National strategy for water (2012-2042);
- National strategy for biodiversity with action plan (2018-2023);
- Strategy for the environment and climate change (2014-2020);
- Communication strategy and action plan for climate change (2022-2030);
- Fourth national plan for climate change (2023);
- Regional plan for the management of waste in the South-West region (2016);
- Plan for stopping the creation of waste in the Republic of North Macedonia (2022-2028);
- Plan for the management of waste in the Republic of North Macedonia (2021-2031);
- Plan for the management of the World Natural and Cultural Heritage Ohrid Region (2020-2029);
- Study for the valorization of the natural values of Jablanica Mountain (2006).

Horizontal interrelation with the relevant planning and strategic documents at a local level

Relevant documents that affect the planning and usage of the space within the borders of the pilot area:

- Spatial plan of municipality of Struga;
- Strategy for sustainable development of the municipality of Struga (2006-2011);
- General urban plan of the municipality of Struga (2003);
- Amendment of the general plan for the city of Struga (2007);
- Basic urban plan for the municipality of Vevchani (1980-2000);
- General urban plan for Vevchani (1997-2007);
- Integral plan for local development of the municipality of Vevchani (2019-2022);
- Plan for the management of Nature Monument Vevchani Springs (2019-2029).

It should be noted here that within the boundaries of the pilot area there are a large number of urban documents that refer only to urbanized areas. These documents are not subject to analysis, as they are not relevant to the current study.

SPATIAL PLANNING AT A NATIONAL AND LOCAL LEVEL

Spatial planning in the Republic of North Macedonia takes place at two levels – national and local. There is also regional development planning, but not regional planning in the sense of spatial planning, such as exists in some European countries, as in Germany, for example. The National Spatial Plan is a comprehensive and long-term planning document for the territory of the entire Country, which is prepared in order to achieve the goals of spatial organization

which ensure the terms of use, protection, and management of the Country's space as a particularly valuable and limited national treasure, and to achieve the prerequisites for societal and economic development, protection of the environment and nature, protection of cultural goods, and rational use of natural and cultural resources. This highest strategic, developmental document contains the setup for the planning concepts and solutions of all fields relevant to spatial planning, and provides guidelines for the preparation of lower-level planning documentation. In accordance with the Law, the Spatial Plan of the Country is developed with: spatial plans for regions, spatial plans for areas of special interest to the Country (such as, for example, national parks), and spatial plans for local self-government units (municipalities) and the city of Skopje.

Regional development planning is regulated by the Law on Balanced Regional Development, for the purpose of which planning regions have been established which represent territorial units for statistics at the third level (NTES-3), determined in accordance with the nomenclature of territorial units for statistics. There are eight planning regions in the Republic of North Macedonia, and the targeted municipalities (Struga and Vevcani) in this study belong to the Southwest planning region.

There is also a legal possibility for the preparation of separate municipal spatial plans, which also present a more detailed elaboration of the spatial plan of the country. Currently, the target pilot area is covered by the Spatial Plan of the Ohrid-Prespa region (2005-2020). That is the latest Plan that is still in force, according to which the so-called Terms for planning the space are issued, which essentially represent an excerpt from the Plan and provide guidelines for the development of the planning documentation at the lower levels.

In general, the systemic and hierarchical organization of spatial and urban planning is regulated by laws, whose implementation is the responsibility of several institutions, through the creation, adoption, and implementation of the Spatial Plan of the Country, urban plans, and other types of urban documentation.

The first level consists of spatial plans made by the Assembly of the Republic of North Macedonia. In this category, the top document is the Spatial Plan of the Republic of North Macedonia, also called the "Constitution of Planning", followed by the spatial plans that refer to smaller spatial scopes and constitute an elaboration of the Plan. The comprehensiveness and integrity of the Plan, the procedure it undergoes, and the very fact that it is adopted by the National Assembly give the decisions and provisions of each spatial plan a legally binding character.

The second level includes strategies, management plans and other planning documents carried out by the Government of the Republic of North Macedonia, ministries, and other competent entities. These documents are not as comprehensive as the Spatial Plan, with which they must be aligned. Some of the documents represent sectoral strategies, often with a time horizon shorter than that of the Spatial Plan, and some refer to the implementation of strategic decisions through specific activities with established entities (management plans).

The third level refers to the urban plans and projects in which the policies and measures contained in the documents of the first and second level are incorporated. This type of documentation is usually carried out at a local level, by the councils of the local self-government

units, and if it is a matter of plans of country-wide importance, they are adopted by the Ministry of Transport and Communications.

SPATIAL PLANNING LEGISLATION

Until recently, the system of spatial and urban planning in the Republic of North Macedonia was regulated by a single law – the Law on Spatial and Urban Planning (Official Gazette of the Republic of Macedonia no. 199/14, 44/15, 193/15, 31/16, 163/16, 90/17, 64/18 and 168/18), which was in force until 18.06.2020. With the entry into force of the new Law on Urban Planning (Official Gazette of the Republic of Macedonia no. 32/20), the Law on Spatial and Urban Planning ceased to be valid, which unfortunately led to the activity of spatial planning being, temporarily, incompletely regulated, up until the drafting of a new Law on Spatial Planning (the drafting of which is in progress). The systematic solution is such (with the Law on Organization of the Country's Administrative Bodies), that it is decided that instead of having one law for which two institutions will be competent, it is divided into two separate laws (spatial and urban). The Ministry of Environment and Spatial Planning is responsible for spatial planning, while the Ministry of Transport and Communications is responsible for urban planning.

Since the most important role is played by legislation in the planning and usage of the space, below is the list of laws that have an impact on planning and the manner of using space:

- Law on Urban Planning (Official Gazette of the Republic of Macedonia no. 32/20);
- Law on Spatial and Urban Planning (Official Gazette of the Republic of Macedonia no. 199/14, 44/15, 193/15, 31/16, 163/16 and 64/18) (no longer in effect, but some policies are still valid according to the transitional and final policies of the Law on Urban Planning);
- Law on Balanced Regional Development (Official Gazette of the Republic of North Macedonia no. 24/21);
- Law on Implementation of the Spatial Plan of the Republic of Macedonia (Official Gazette of the Republic of Macedonia no. 39/2004);
- Law on the Environment (Official Gazette of the Republic of Macedonia no. 53/05, 81/05, 24/07, 159/08, 83/09, 48/10, 124/10, 51/11, 123/12, 93/13, 187/13, 42/14, 44/15, 129/15, 192/15, 39/16 and 99/18);
- Law on Nature Protection (Official Gazette of the Republic of Macedonia no. 67/04, 14/06, 84/07, 35/10, 47/11, 148/11, 59/12, 13/13, 163/13, 41/14, 146/15, 39/16, 63/16 and 113/18);
- Law on Cultural Heritage (Official Gazette of the Republic of North Macedonia no. 20/04, 115/07, 18/11, 148/11, 23/13, 137/13, 164/13, 38/14, 44/14, 199/14, 104/15, 154/15, 192/15, 39/16, 11/18 and 20/19);
- Law on the Management of the World Natural and Cultural Heritage of the Ohrid Region (Official Gazette of the Republic of North Macedonia no. 75/10);
- Law on Agricultural Land (Official Gazette of the Republic of Macedonia no. 135/07, 18/11, 148/11, 95/12, 79/13, 87/13, 106/13, 164/13, 39/14, 130/14, 166/14, 72/15, 98/15, 154/15, 215/15, 7/16, 39/16, 161/19 and 178/21);
- Law on Waters (Official Gazette of the Republic of Macedonia no. 87/08, 6/09, 52/16, 161/09, 83/10, 51/11, 44/12, 23/13 and 163/13);

- Law on Urban Greenery (Official Gazette of the Republic of Macedonia no. 11/18) – applies only to urbanized environments;
- Law on Mineral Resources (Official Gazette of the Republic of Macedonia no. 136/12, 25/13, 93/13, 44/14, 160/14, 129/15, 192/15, 39/16, 53/16, 120/16, 189/16 and 7/19);
- Law on Forests (Official Gazette of the Republic of Macedonia no. 64/09, 24/11, 53/11, 25/13, 79/13, 147/13, 43/14, 160/14, 33/15, 44/15, 147/15, 7/16 and 39/16);
- Law on Pastures (Official Gazette of the Republic of Macedonia no. 03/98, 101/00, 89/08, 105/09, 42/10, 116/10, 164/13, 193/15 and 215/15).

The Law on the Implementation of the Spatial Plan of the Republic of Macedonia (Official Gazette of the Republic of Macedonia no. 39/2004) was adopted at the same time as the adoption of the Spatial Plan of the Republic of Macedonia (2004-2020). Given that the planning horizon of this Spatial Plan has already been exceeded, in 2017 a new procedure was started for the development of a new Spatial Plan of the Country, which is still ongoing, and is expected to be completed in a few years. Still, because in accordance with the Law, the Spatial Plan is a document with permanent value, it is still considered to be in force up until a new Spatial Plan is adopted. There are also spatial plans that are an elaboration of this Spatial Plan, and whose planning horizon is longer, such as, for example, the Spatial Plan of the Eastern Planning Region or the Spatial Plan of National Parks Pelister and Mavrovo, whose planning horizons are up to 2030.

Since spatial plans are adopted by the highest legislative body in the Country – the Assembly of the Republic of North Macedonia, in a procedure that is the same as the adoption of laws, spatial plans are considered to be documents at the level of Law, that is, they must be adopted and implemented.

The procedures for the development and adoption of the spatial plans and the plans for the management of protected areas and their planning horizons/validity

The preparation and adoption of the spatial plans and management plans are stipulated by the law. A spatial plan for a national park is drawn up in accordance with the Law on Spatial and Urban Planning (Official Gazette of the Republic of Macedonia no. 199/14, 44/15, 193/15, 31/16, 163/16 and 64/18), that is, the Law on Urban Planning (Official Gazette of the Republic of Macedonia no. 32/20), (which in its transitional and final policies refers to the Law on Spatial and Urban Planning, until the adoption of the new Law on Spatial Planning), as well as according to the Law on Nature Protection (Official Gazette of the Republic of Macedonia no. 67/04, 14/06, 84/07, 35/10, 47/11, 148/11, 59/12, 13/13, 163/13, 41/14, 146/15, 39/16, 63/16 and 113/18), whose policies also envisage the creation of spatial plans for protected areas. It is a procedure that takes place in two stages, a draft and a proposal-plan, and which lasts quite a long time (over 5 years). Competent institutions are: the Ministry of Environment and Spatial Planning, which is the commissioner and coordinator of the entire procedure, the Spatial Planning Agency, which is the only professional and competent institution for the preparation of spatial plans in the Country, the Government, which is the proposer, and the National Assembly of the Republic of North Macedonia, which adopts the plan.

The development of a management plan is stipulated by the Law on the Protection of Nature (Official Gazette of the Republic of Macedonia no. 67/04, 14/06, 84/07, 35/10, 47/11, 148/11, 59/12, 13/13, 163/13, 41/14, 146/15, 39/16, 63/16 and 113/18) and is made in accordance with the Manual on the content of management plans for protected areas and the content of the yearly programs for the protection of nature (Official Gazette of the Republic of Macedonia no. 26/12). The Public Enterprise National Park (which in the case of Jablanica is yet to be formed, after the declaration of the area as a national park), is responsible for the production of the management plan, and the plan can be prepared by internal or external experts. It, just like the spatial plan, is created in two stages (as a draft and a proposal plan), and a public discussion is also carried out, in order to include the opinion of the public and stakeholders, along with an SEA (Strategic Environmental Assessment) on the environment from the implementation of the plan). The plan is approved by the Ministry of Environment and Spatial Planning and adopted by the management board of the national park (which also decides at the beginning of the process on the need for a new management plan). These types of plans have a planning period of 10 years.

Competent institutions for implementing management plans are the public enterprises – National Parks. The implementation of the management plans is carried out through the so-called Operational Plan, which is realized with the annual programs for the management of the protected area. For this purpose, special funds are foreseen in the financial plan of the institution, that is, in its annual budget. The implementation of management plans is monitored through the Annual Program Report for the previous year.

Cooperation of the municipalities with the responsible institutions and participation of the public in the planning process and development of planning documents at a local level

The involvement of municipalities and their role in the preparation of planning documents is realized through Participatory Bodies, which are formed in accordance with the Law on Urban Planning (Official Gazette of the Republic of Macedonia no. 32/20). Namely, to ensure inclusiveness, participation and publicity in the process of urban planning, municipalities must form a participatory body at the initiative of the Mayor. The participatory body consists of members of the Urban Planning Commission of the Municipality determined by the Mayor, experts employed by the legal entity that prepares the urban plan that is the subject of discussion, and especially persons who are representatives of urban and local communities, representatives of non-governmental organizations from different segments of urban life, associations of citizens and civil activists from the territory of the Municipality that represent various groups of citizens, as well as citizens who are experts in the field of urban planning and other professional areas that are relevant for the planning and sustainable development of the city. The participatory body is formed of voluntarily registered persons. Namely, the participatory body represents the various interests and interest groups in the local community and conveys the attitudes, opinions, and needs of citizens and legal entities, monitors the planning situation by offering initiatives, directions, and suggestions for the preparation of planning solutions, and

in the procedure for making and adopting the plans, it considers the planning programs and the planning solutions of the urban plans in their working version.

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

Although GI is a new term, it is not a new idea (Benedict and McMahon, 2002; Wright, 2011). The GI concept in the countries of the European Union began to be incorporated as part of spatial planning a little more than 10 years ago. However, it is a relatively unknown concept among the main stakeholders in spatial planning in the Republic of North Macedonia. In the Republic of North Macedonia, within the framework of several projects at the regional level in the field of GI, the following two studies have been prepared:

- Study on the development of GI and the status of ecological connectivity in Albania, Bosnia and Herzegovina, Montenegro, Serbia, and North Macedonia, along with the Regional Plan for the development of GI and ecological connectivity, which has already been approved by the EU;
- Large carnivores in the Dinarides: Management, monitoring, threats and conflicts: Establishing a transnational exchange platform for the management of large carnivores in the Dinaric region (Background Report).
- In addition to these two studies, three national reports on ecological corridors have been prepared within the framework of the GEF STAR 5 project, namely:
- Guidelines for managing forests within the identified ecological corridors and establishing GI, as part of the Proposed National Ecological Network (MAK-NEN) for the linear corridor Bukovikj-Sretkovo and the regional corridor Bukovikj-Kolari;
- Guidelines for managing forests within the identified ecological corridors, as part of the Proposed National Ecological Network (MAK-NEN) for the linear corridors Dren-Vitolishte and Kozjak (Pletvar) and the regional corridor Selechka Mountain;
- Manual of measures – design of “Green Crossings”.

From the analysis carried out in this study, it can be concluded that, despite the coverage of the pilot area with a large number of planning documents, a major drawback is that they all refer to a wider area (of the country and/or the region), and not specifically to the area itself, and that they are all outdated and with exceeded planning horizons. A particularly negative aspect is the lack of newer spatial plans for the municipalities of Struga and Vevchani, and the fact that the legal possibility for the creation of new municipal spatial plans has not been used, which would have regulated the organization, use, arrangement, and protection of the specific space in more detail, in accordance with modern conditions and needs. In addition, the concept of GI is not defined in any law, nor is it integrated in any of the planning documents that could ensure its implementation at a national, regional, and local level, or in a cross-border context.

This is because the traditional, conventional model of spatial planning (on which existing spatial plans are based) did not include the concepts of newer phenomena such as climate change and GI, and therefore does not offer the possibility to fully address all aspects related to environmental protection and sustainable development with appropriate acceptance of spe-

cific functions and their consistency in the wider spatial context. But today, a new Law on Spatial Planning is being drafted, as well as a new Spatial Plan of the State, in which the concept of GI will be integrated.

One of the biggest problems in recent times is increased, accelerated urbanization and the many concessions made for the exploitation of natural resources, which is the main reason for the fragmentation of productive land and landscapes. These processes cause the reduction of natural habitats and so on. An additional drawback is that, despite the exceptional natural values and significance of the pilot area, it has not yet been declared a protected area, which would contribute to its proper management. Adequate management would be achieved through the establishment of a Public Enterprise – National Park institution, which would provide financial resources for management, appropriate personnel who will take care of the area, preparation of planning documents and their implementation, cross-border cooperation, etc.

The involvement of GI in planning and planning documents and recommendations for their improvement

GI is an effective counterbalance to the processes that degrade the environment, and that is why integrating the concept of GI into spatial planning is very important. Bearing that in mind, the following recommendations are given as concluding observations of this study, which would contribute to the prevention of the negative trends of landscape degradation, and also to the revitalization of the space and the development of GI:

General recommendations

- A Study for the valorization of the natural values and biodiversity of Jablanica Mountain should be prepared;
- Based on the results of the study, the area should be proposed for designation as a protected area in the category of a National Park;
- Following the proclamation of the area as a National Park, a Public Enterprise National Park "Jablanica" should be established – an institution that will manage the area;
- Following the preparation of the new Spatial Plan of the Republic of North Macedonia and the new Law on Spatial Planning, a new Spatial Plan for the Jablanica National Park should be prepared (according to a new methodology, including GI and adaptation measures for climate change);
- After the preparation of the Spatial Plan of National Park Jablanica, a Management Plan for National Park Jablanica should be developed;
- These planning frameworks should incorporate GI: GI should be integrated into existing planning frameworks. This can help ensure that GI is considered early in the planning process and is aligned with other planning objectives;
- An initiative should be launched to revise the issued concessions for exploitation of mineral resources in the area, and concessioners should be obligated to undertake offset measures;
- The unplanned and illegal felling of the forest should be prevented.

Specific recommendations

- The opinion of the local population should be sought: The participation of the local population should be encouraged to ensure the creation of quality green spaces that meet their practical needs;
- Civil society should be considered a key stakeholder in GI management: Residents possess specific knowledge about their territory and can support the promotion of GI through collective actions;
- GI should be implemented in urban areas: Planning green and multifunctional urban spaces, as well as infrastructure for development in an urban context, should be prioritized;
- Unused land (unoccupied urban plots) should be transformed into green areas;
- Well-connected, multifunctional GI should be deployed in the rural landscape;
- Urban-rural partnerships should be established: This would facilitate a more efficient spread of economic activities while providing access to ecosystems and their services for local settlement dwellers;
- Encourage GI projects as cost-effective alternative solutions: prioritizing natural/semi-natural land redistributions in the context of agroecology and forestry (greening measures);
- Restoration measures should be implemented in degraded areas to improve landscape permeability;
- Green corridors and natural areas should be created;
- Plant rows of trees and low vegetation along roads: This helps mitigate climatic effects on roads and communal infrastructure, such as providing shade, mitigating precipitation, regulating water flow, and absorbing vehicle exhaust gases;
- Maintain natural buffer zones around areas of industrial activity;
- Reclaim abandoned industrial sites as green areas for recreation and potential elements of the GI network;
- Create vegetation corridors along cycling or walking paths, such as hedges, to enhance landscape diversity;
- Prioritize defragmentation measures to mitigate the impacts of intensified agriculture and road infrastructure on species movement;
- Prevent fragmentation of habitats to enable the unobstructed movement of animals in search of mates, food, and shelter;
- Provide underground or above-ground natural passages for wild species across road infrastructure;
- Plan GI as a cross-border, dynamic, and adaptable network to mitigate climate change;
- Foster inter-municipal cooperation in land-use planning, particularly to enhance environmental connectivity at local and regional levels. Coordinated management between sectoral departments is crucial, and methodological guidelines, training, and a participatory approach can help overcome obstacles to creating GI.

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18. Law on Spatial and Urban Planning (Official Gazette of the Republic of Macedonia no. 199/14, 44/15, 193/15, 31/16, 163/16 and 64/18) (no longer in effect, but some policies are still valid according to the transitional and final policies of the Law on Urban Planning).
19. Law on Urban Greenery (Official Gazette of the Republic of Macedonia no. 11/18) – applies only to urbanized environments.
20. Law on Urban Planning (Official Gazette of the Republic of Macedonia no. 32/20).

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PERSPECTIVES FOR THE DEVELOPMENT OF URBAN AREAS IN THE REPUBLIC OF NORTH MACEDONIA

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ABSTRACT

The growth and development of urban areas became an important topic in recent decades, not only in the field of planning and spatial research, but also in the processes of decision-making and creation of policy and strategy.

This paper analyzes spatial changes and development trends in North Macedonia's four largest urban morphological areas—Skopje-Kumanovo, Bitola, Prilep, and Tetovo-Gostivar—utilizing data from the Urban Atlas provided by the Copernicus Land Monitoring Service. The Urban Atlas contains geospatial data on population size and land use patterns.

The study provides conceptual frameworks to improve territorial development policies and methodology for creating spatial and urban planning documents. By integrating geospatial data with a focus on enhancing strategies for managing territorial development, this research contributes to improvement spatial planning practices and may represent basis for further research in this fields. The aim of the paper is to detect current state and determine main perspectives for sustainable urban and spatial development in North Macedonia.

Keywords: Spatial Changes, North Macedonia, Urban Areas, Urban Atlas, Development Trends

INTRODUCTION

Urbanization is a process that continues intensively into the 21st century, contributing to further polarization between urban and rural areas by increasing the participation of inhabitants in urban areas. This represents the challenges in arranging and organizing settlement networks and their governance in territorial development management (United Nations, 2019; Castells-Quintana & Herrera-Idárraga, 2019).

Despite the increase in urbanization, cities in the Republic of North Macedonia are characterized by a general process of depopulation and demographic aging, strengthening of regional disparities, problems of the development of urban culture and deterioration of the quality of environmental protection, including the unfavorable consequences of climate change. The complexity of settlement networks, urban systems and city planning requires a special approach to directing development trends and activities. Cities in North Macedonia form a heterogeneous system of settlements of different demographic size, economic development and functional capacity, which is a consequence of different development predispositions in the

geographical and socio-historical context (Markoski et al, 2012). Continuing the analysis, this study examines the fundamental spatial characteristics of the four largest cities: Skopje-Kumanovo, Bitola, Prilep, and Tetovo-Gostivar, for which data are available from the Urban Atlas database. Urban Atlas (UA) provides land cover and land use data with the integrated population estimates in 788 Functional Urban Areas (FUA) with more than 50,000 inhabitants in countries that belong European Economic Area (EEA) and the United Kingdom for the 2018 reference year. A FUA consists of a city and its commuting zone. FUA therefore consist of a densely inhabited city and a less densely populated commuting zone whose labor market is highly integrated with the city (Dijkstra et al., 2019).[1]

BASIC CHARACTERISTICS OF URBAN AREAS IN NORTH MACEDONIA

According to the Census data from 2021, the network of settlements in North Macedonia consists of 1,792 settlements with 1,836,713 inhabitants. The largest number of inhabitants (57%) live in large settlements (more than 10,000). On the other hand, 526,502 inhabitants lived in the area of the City of Skopje, which is 29% of the total population of North Macedonia. The disproportion in the demographic size of Skopje and other larger cities is a consequence of the incoherence and asymmetry of the urban system of North Macedonia. Cities in North Macedonia are spatially dispersed and unevenly distributed in terms of population concentration and functions. The dominance of Skopje and its urban area, realizes a strong urban-demographic polarization in the urban system of North Macedonia, which is confirmed by the size of the 10 most numerous urban settlements (Table 1).

Table 1. The ratio of demographic sizes of the ten largest urban settlements in RSM, Census 2021. year

	Urban settlement	Population	Index in relation to Skopje	Index in relation to Previous urban settlement
1.	Skopje[2]	422540	1.000	-
2.	Kumanovo	75051	0.178	0.178
3.	Bitola	69287	0.164	0.923
4.	Prilep	63308	0.150	0.914
5.	Tetovo	63176	0.150	0.998
6.	Štip	42000	0.099	0.665
7.	Veles	40664	0.096	0.968
8.	Ohrid	38818	0.092	0.955
9.	Strumica	33825	0.080	0.871
10.	Gostivar	32814	0.078	0.970

Source: Authors calculation

The analysis of land cover changes in urban settlements is possible for FUAs, i.e., cities with more than 50,000 inhabitants and their gravitational areas. The UA Land Use/Land Cover classification is derived from CORINE Land Cover and is composed of 27 classes distributing among 5 thematic groups: 1. Artificial surfaces 2. Agricultural areas 3. Natural and (semi-) natural areas 4. Wetlands 5. Water. Four hierarchical levels are defined in the nomenclature for

[1] The dataset maps land cover and land use for 17 urban classes with the Minimum Mapping Unit (MMU) of 0.25 ha and for 10 rural classes with the MMU of 1 ha and is available as vector data (https://land.copernicus.eu/en/products/urban-atlas/urban-atlas-2018).
[2] Number of inhabitants only in urban settlements in municipalities which administratively belong to the City of Skopje.

artificial surfaces (class 1) while only two are defined for the non-artificial ones (classes 2-5) (EEA, 2020). Data are available for four cities in the Republic of North Macedonia: FUA Skopje (with Kumanovo in gravitational zone), FUA Tetovo (with Gostivar), FUA Bitola and FUA Prilep (Figure 1 and 2). Land cover data are joined with population data enabling realistic estimates of the population by land use/cover categories and population densities (Гајиħ & Круниħ, 2020).

Thus 893,248 inhabitants in North Macedonia lived in the area covered by FUA, while 840,039 inhabitants lived in the areas classified as artificial (classes 11100-14200)[3], i.e., 46% of the total population of the Republic of North Macedonia was covered with FUA (Table 2).

Table 2. Structure of land cover, population and population density in urban areas (classes 11100-14200)

Code 2018	Class 2018	Total population	%	Area (ha)	%	Mean Population density (inhabitants per ha)
11100	Continuous urban fabric (S.L. : > 80%)	235222	28	2529	6	90
11210	Discontinuous dense urban fabric (S.L. : 50% - 80%)	286571	34	4636	11	59
11220	Discontinuous medium density urban fabric (S.L. : 30% - 50%)	135817	16	3685	9	35
11230	Discontinuous low density urban fabric (S.L. : 10% - 30%)	100713	12	4118	10	22
11240	Discontinuous very low density urban fabric (S.L. : < 10%)	59331	7	7165	18	8
11300	Isolated structures	1847	0	720	2	3
12100	Industrial. commercial. public. military and private units	20054	2	7018	17	2
12210	Fast transit roads and associated land	0	0	582	1	0
12220	Other roads and associated land	0	0	4845	12	0
12230	Railways and associated land	0	0	517	1	0
12400	Airports	0	0	295	1	0
13100	Mineral extraction and dump sites	0	0	1764	4	0
13300	Construction sites	0	0	372	1	0
13400	Land without current use	0	0	970	2	0
14100	Green urban areas	0	0	1049	3	0
14200	Sports and leisure facilities	484	0	491	1	1
Total		840039	100	40757	100	14

Source: Authors calculation

In the structure of artificial surfaces, the highest share is in classes of discontinuous very low density urban fabric (18%) and in industrial, commercial, public, military and private units (17%). Significant contribution to artificial surfaces have classes related to other roads and associated land (12%), discontinuous dense urban fabric (11%) and discontinuous low density urban fabric (10%). Other anthropogenic areas encompass about 32% of total artificial surfaces.

[3] Complete classification is available at https://land.copernicus.eu/en/technical-library/urban_atlas_2012_2018_mapping_guide/@@download/file

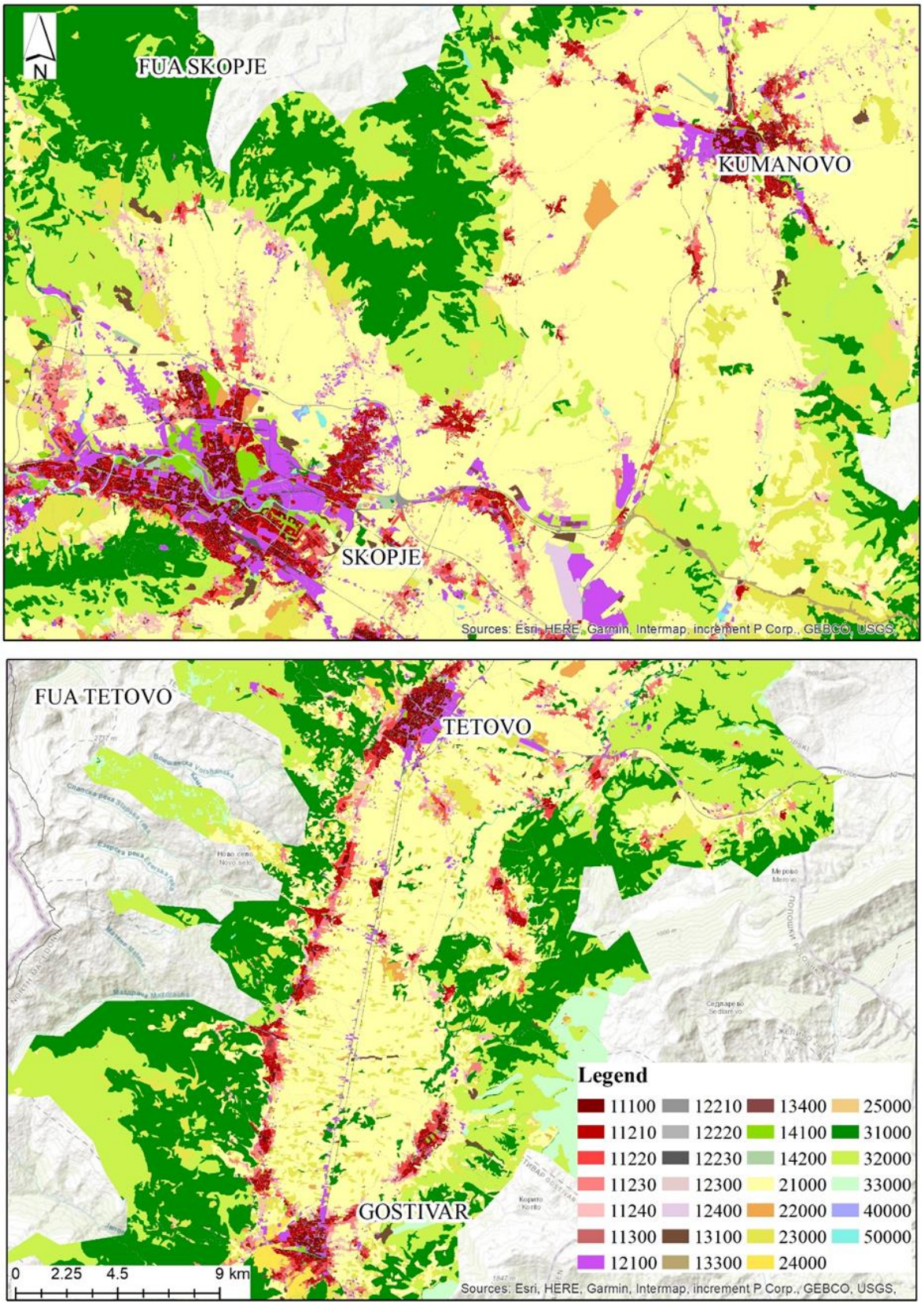

Figure 1. Illustrative example of FUA Skopje and FUA Tetovo land cover

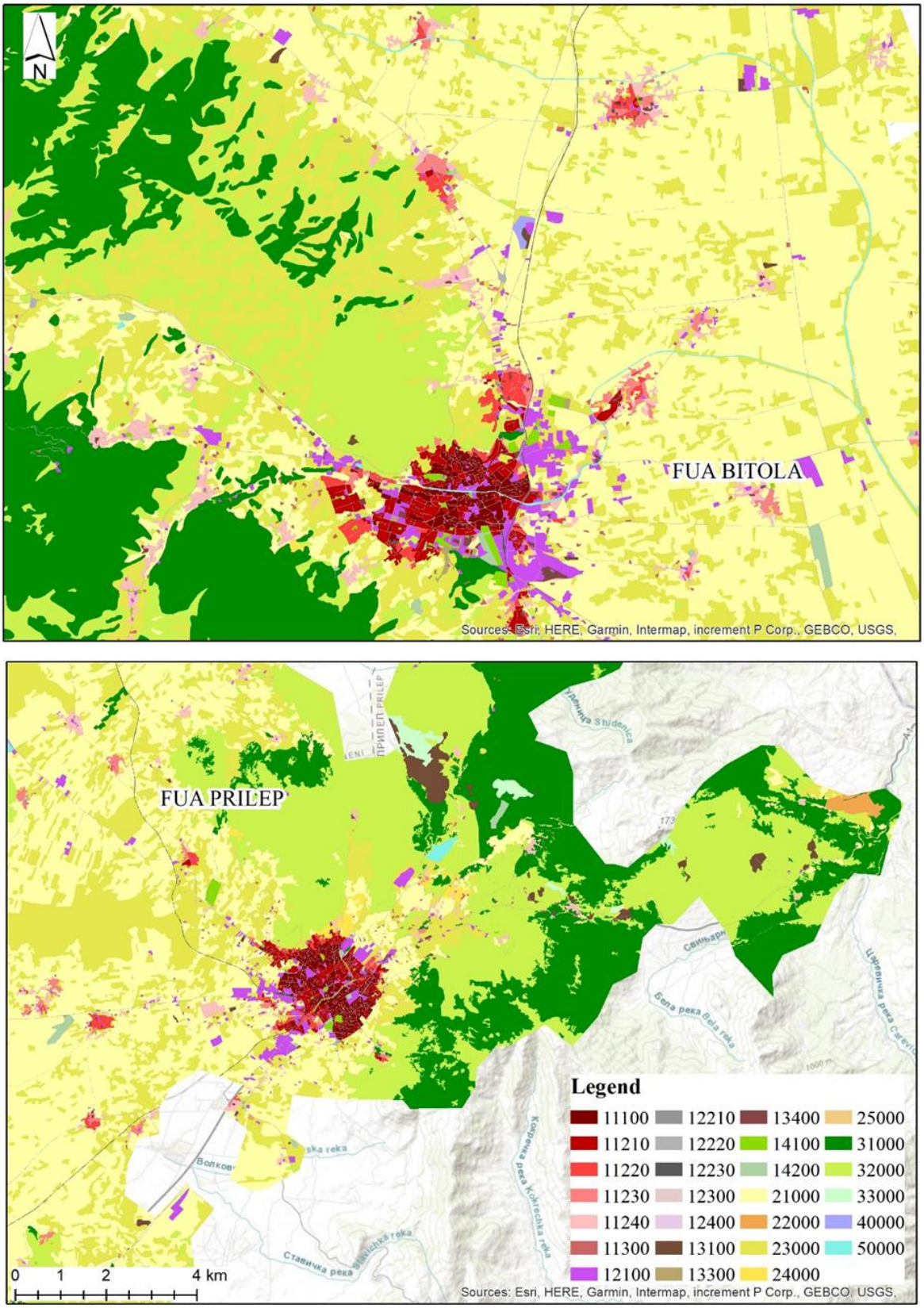

Figure 2. Illustrative example of FUA Bitola and FUA Prilep land cover

Within artificial surfaces the largest number of inhabitants was recorded in discontinuous dense urban fabric (34%) and continuous urban fabric (28%). The rest of the total population is distributed in classes: discontinuous medium density urban fabric (16%), discontinuous low

density urban fabric (12%) and discontinuous very low density urban fabric (7%). The highest population densities are represented in continuously built-up areas where the percentage of built-up is greater than 80%. The average population density in these zones is 90 inhabitants per ha, with the maximum density of 247 inhabitants per ha in FUA Skopje. In discontinuous dense urban fabric areas mean population density ranged from 59 inhabitants per ha (in areas of high built-up density) to 8 inhabitants per ha in areas of very low built-up density. Low population densities are mostly related to isolated areas and other areas where there are almost no inhabitants.

SKOPJE URBAN AREA

According to UA methodology FUA Skopje covered the surface of 1,834 km^2. In FUA Skopje lived 584,603 inhabitants, which is 66% of total population covered with FUA in North Macedonia. In administrative sense FUA Skopje covered parts of territory of the City of Kumanovo (Figure 3).

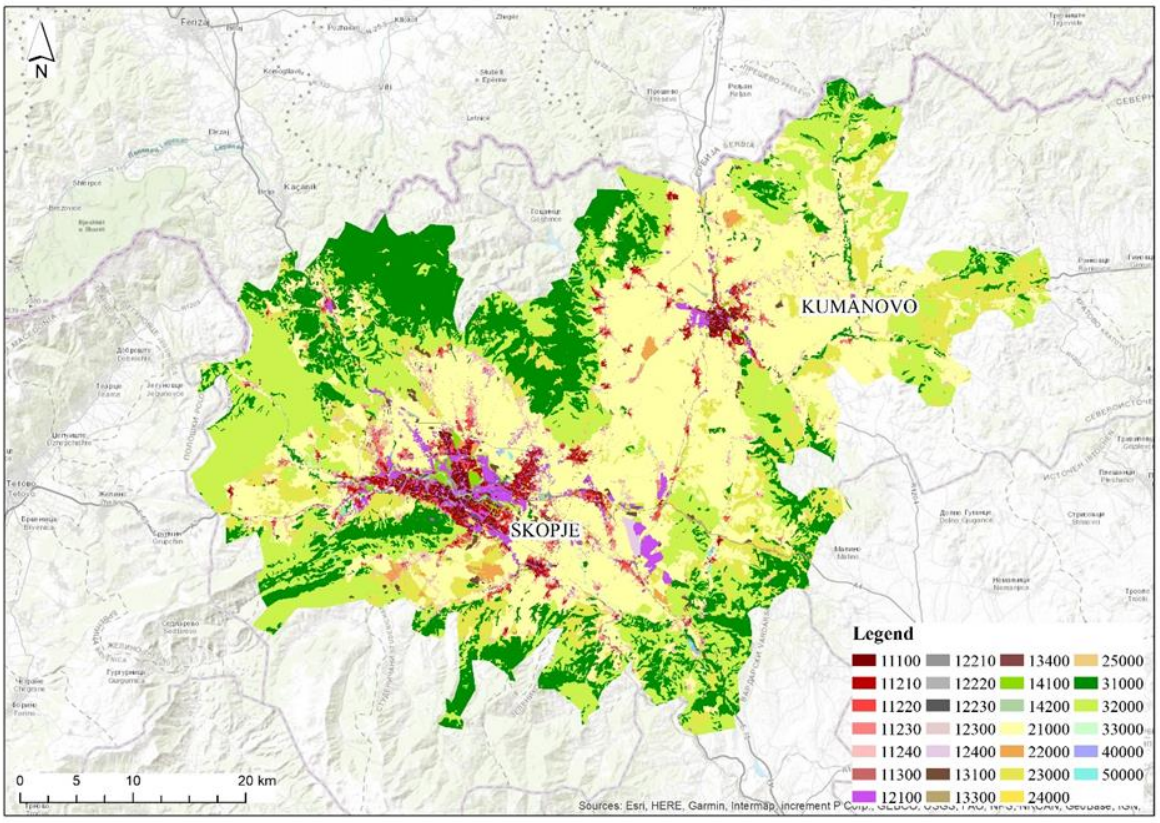

Figure 3. FUA Skopje

Compared to the previous analysis that included all the FUA in Northern Republic of Macedonia the Skopje anthropogenic area has a higher population density of and higher level of built-up areas.

Classes that describe artificial surfaces (classes 11100-14200) occupied about 232 km^2 which is about 10% of the total area of the FUA Skopje. In the structure of artificial classes, the classes that belong industrial commercial public military and private units have the largest share

(20%), discontinuous very low density urban fabric covers 16% of total artificial surfaces, discontinuous dense urban fabric 12%, and roads and associated land around 11%. Significant share in artificial surfaces have classes discontinuous low density urban fabric (9%), Discontinuous medium density urban fabric (8%) and continuous urban fabric with high density (6%), while green urban areas covered (3%) as well as mineral extraction and dump sites (4%). Other classes covered around 11% of total artificial surface (Table 3).

Table 3. Structure of land cover, population and population density in Skopje urban areas.

Code 2018	Class 2018	Total population	%	Area (ha)	%	Mean Population density (inh/ha)
11100	Continuous urban fabric (S.L. : > 80%)	164151	30	1446	6	119
11210	Discontinuous dense urban fabric (S.L. : 50% - 80%)	198438	36	2811	12	71
11220	Discontinuous medium density urban fabric (S.L. : 30% - 50%)	81075	15	1911	8	40
11230	Discontinuous low density urban fabric (S.L. : 10% - 30%)	58709	11	1967	8	25
11240	Discontinuous very low density urban fabric (S.L. : < 10%)	28864	5	3786	16	7
11300	Isolated structures	645	0	259	1	3
12100	Industrial. commercial. public. military and private units	15257	3	4676	20	3
12210	Fast transit roads and associated land	0	0	453	2	0
12220	Other roads and associated land	0	0	2442	11	0
12230	Railways and associated land	0	0	331	1	0
12400	Airports	0	0	276	1	0
13100	Mineral extraction and dump sites	0	0	850	4	0
13300	Construction sites	0	0	274	1	0
13400	Land without current use	0	0	651	3	0
14100	Green urban areas	0	0	741	3	0
14200	Sports and leisure facilities	374	0	277	1	1
Total		547513	100	23152	100	17

Source: Authors calculation

A total of 547,513 inhabitants lived in the areas classified as artificial, i.e. 95% of the total population of the functional urban area of the city of Skopje, i.e. 30% of the total population of the Republic of North Macedonia is included in a functional area. The largest number of inhabitants lived in discontinuous dense urban areas (36%), while in compactly built-up areas lived 30%.

The highest population densities are present in continuously built-up areas 119 (inhabitants per ha), which is significantly high compared to the average value of all four FUAs. Low population densities are mostly related to isolated areas.

THE STARTING POINTS FOR PLANNING AND DEVELOPMENT OF URBAN AREAS

Based on the UA geospatial data, it is possible to determine the basic tendencies of the development of urban systems and areas in the Republic of North Macedonia. The existing system of settlements in the Republic of North Macedonia is the result of the previous develop-

ment of urban systems and its further development will be based on the intensification of spatial and functional relations and links between urban areas. Primarily, this refers to the urban (metropolitan) area of Skopje, which will integrate adjacent rural zones by enhancing its functional capabilities and transportation infrastructure. Additionally, the formation of agglomerations (such as Kumanovo, Tetovo-Gostivar, and Bitola-Prilep) and the fostering of smaller urban areas and urban centers will play integral roles in the spatial development.
The network of urban areas is consisted of:

1. The metropolitan area of Skopje comprises the agglomerations of Skopje, Kumanovo, and Tetovo-Gostivar. Functionally, the development of the Skopje metropolitan area has been driven by the spatial integration of urban centers and their urban areas along the line Kumanovo-Skopje-Tetovo-Gostivar. The metropolitan area of Skopje serves as the primary driver of development in the Republic of North Macedonia and includes about 760,000 inhabitants, which is around 40% of the total population of the country. The core of the metropolis is the agglomeration system of Skopje - a polycentric urban agglomeration of about 590,000 inhabitants.
2. Agglomerations, as complex regional functional-urban systems comprised of multiple settlements have the character of functionally urban regions/areas. The urban centers of Tetovo and Gostivar constitute an agglomeration system within the area of 1060 square km. Bitola-Prilep agglomeration represents an influential zone that encompasses around 140,000 inhabitants. Potentially, these agglomerations could play a pivotal role in achieving a more balanced development for the Republic of North Macedonia.
3. Urban areas consist of city settlements functionally networked with their surroundings. Formed from urban cores with a higher degree of centrality and functionally compatible surrounding settlements.
4. 4.Urban centers in the rural environment appear as smaller urban areas in the rural environment and represent centers of local integration.

CONCLUSION

The paper presents an example of the use of the UA in the area of the Republic of North Macedonia. The research results provide a summary analysis of the land cover of all urban areas covered by the UA methodology. A special analysis included the urban area of the City of Skopje with the aim of a more realistic view of spatial relations considering the dominant role and importance of Skopje in the spatial-functional organization of North Macedonia. Based on the conducted analyses possible directions for the development of urban areas in North Macedonia were proposed. The obtained results can represent inputs in the creation and production of strategies and spatial planning and urban planning documents.

Trough the analysis of land cover and the examination of spatial relationships, the paper presents only one of the possible ways of utilizing UA. Numerous studies indicate the significance of UA data in analyzing population dynamics (Pirowski & Timek, 2018), as auxiliary data

for flood risk assessment (Skilodimou et al., 2021), evaluating the accessibility of green infrastructure (Ruche et al., 2018; Kovács et al., 2019), urban agriculture (Živanović Miljković et al., 2022), etc.

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HOT SPOT OF REHOVA IN ALBANIA THROUGH SUSTAINABLE DEVELOPMENT

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ABSTRACT

Rehova is one of the sixteen priority hotspots identified in Albania with a total area of approximately 100 ha out of 255.5 ha scattered over the entire territory of the country. The copper mine of Rehova is located 20 kilometers from Korça city in the southern direction, Korça-Erseka national road. The facilities were established near the Rehova village, 1.5 Km in the northern direction and today they do not operate. The mine is situated on the hill slope of a small valley and on the east hill there are the ruined premises of the former enrichment factory. A few hundred meters from the factory there is a waste dump, which can be described as a dike of approximately 15 meters high, filled with the tailing materials from the enrichment factory. Several sites of dumped mineral are situated in the surroundings near the water stream that passes by the foot of the valley flowing towards Rehova village. Another site of tailings is situated in the surroundings near the water stream that passes by the foot of the valley flowing towards Osumi river.

The Rehova mining terrain represents a hilly-mountain area with soft shapes, which are followed by higher mountain peaks in western and eastern directions. The altitude of the enrichment factory is 1040 meters above sea level, and the average altitude of the study area is 910 meters. The soil texture in the valley is classified as meadow soil in brown color.

Although the copper enrichment factory is destroyed, the Albanian government has occasionally taken measures to rehabilitate the area or use industrial waste for the enrichment of copper, which has been unsuccessful. The surrounding area, although has wonderful nature, it is not being used for agritourism, the number of inhabitants is decreasing day by day and the inhabitants collect aromatic plants. The adequate protection and restoration of soil ecosystems contaminated by heavy metals require their characterization and remediation (Wuana, R. A. and Okieimen, F. E. 2011).

Keywords: Hot-Spot, copper mining, Albania, Rehova village.

INTRODUCTION

The Korca region is rich in underground, as well as, ground resources who is well known for coal (13 sources), iron, nickel (2 sources), copper (2 sources), powder talc (2 sources), clay (4 sources) asbestos, quartz sands (2 sources), chromium (2 sources), construction materials and decorative stones (AKBN). As a natural soil component, heavy metals are as a rule, present in a small amounts but a high contents occur in some cases as a result of environmental pollution (Elsokkary, H. and Lag, J. 1978). A large number of state industries have been closed, but the consequences of the development of these activities have left their footprint in the region.

The region of Korça has a Mediterranean climate with an attractive nature and landscape of mountainous and hilly nature, three lakes such as Ohrid, Prespa e Madhe & Prespa e Vogel, National Parks and Protected Areas, tourist views with characteristic houses, museum sites, natural landscapes, rare species, etc. Fresh and healthy climate, mineral waters "Dardha & Vithkuq", places of historical and cultural interest such as prehistoric dwellings, archaeological objects, cult objects, potential for sports activities (skiing, fishing, mountaineering), traditional cultural and religious holidays (fairs, carnivals, serenades, etc.), create more favorable conditions for the development of agrotourism than industry.

The Albanian government explored the copper mine and enrichment plant from 1980 to 1990. After the 2000s, the Albanian government tried to put into operation a concession contract for the rehabilitation of the former enrichment plant as well as the reprocessing of the old waste from the landfill for further beneficiation of copper and other minerals. These efforts were unsuccessful, leaving a degraded and problematic environment. Within the site area abandoned premises of the former enrichment factory are located and with a dumpsite of mineral heaps and waste rock, and a tailings dam located few hundred meters from these buildings. Some of these dumpsites consist of piles of minerals, mainly of Cu, Fe and CuFeS2, resulting from the enrichment process.

Shallari et al (1997) highlight that large parts of the Albanian land are covered by soil developed on serpentine rocks. This soil is naturally rich in iron nickel chromium and copper determining the high density of mines that supply raw materials to Albanian metal smelters. Critical load of trace metals in soils is a function of biological uptake, leaching by percolating water, input of the trace metals due to bedrock weathering, and the norms set to protect soils from metal pollution (Paces T. 1998).

As for the anthropogenic background concentration, a large part of it appears to be due to a number of mining activities and smelters. Apart from impacting on soil at the mining/smelter sites themselves, these activities appear to have affected soil concentrations in the larger site areas, where generally high metal concentrations can be identified. Literature on the subject mainly analyze concentrations of heavy metals in agricultural soil next to mining or industrial sites. A reference search on the metal concentration in agricultural land next to the mineral enrichment plants in Guri i Kuq and Bilisht, for example, shows high concentrations of Ni, Cr, Pb Co and Mn, Shallari et al. (1998).

In the area of Progradec and in the area next to Perrenjas, Shallari et al. (1996) report the following heavy metal concentrations in the soil affected by the mining activities widely spread in the area.

In addition, Lushaj et al. (2005), in a study on the concentration of heavy metals in agricultural land show that heavy metals' concentrations in the topsoil around Korce (less than 10 km from Rehove) are very high for nickel and chromium.

In addition, Shallari et al. (1997) report a fairly comprehensive summary of soil concentration of heavy metals measured next to industrial sites throughout Albania. These concentrations, highlight that anthropogenic background concentration can actually achieve very high values which exceed both the DIVs 2009 and the Italian Regulatory threshold values.

DATA AND METHODS

Sampling site

The copper mine of Rehova site is located at Korça District, direction Korça – Erseka national road, some 20 kilometers from Korça city in southern directions. The facilities were established near the Rehova village, a hilly-mountain area with soft slopes, which are followed by higher mountain peaks in western and eastern directions. The Rehove mine site covers an area of approx. 1 km^2, including mine area, the remaining of a former enrichment factory and dumpsites of mine waste near tributary of river Osumi.

Soil sampling, preparation and analyses:

In July 2023, 16 surface soil samples (0-30 cm) were collected from the different locations according to the distance (0m, 10m, 100m and 1km, 2km, 3km, 4km, 5km, 6km, 7km, 8km, 9km, 10km) from the first sample (Sallaku et al. 2009). Subsamples of each soil were air-dried and ground to pass through a 2-mm stainless-steel sieve and are analyzed with METHOD 3051A (https://www.epa.gov/sites/default/files/2015-12/documents/3051a.pdf).

The main characteristics of these soils are given in Table 1. The water content (w %), is calculated as the ratio of the weight of water to the weight of the solids in a given mass of soil and organic C by elementary analysis. Total contents of heavy metals were determined by the mineralization of soil samples in the solution of aqua regia (HCl and HNO3) in the ratio (3:1). The metal concentrations in the extracts were measured by Atomic Absorption Spectroscopy.

Table 1. Chemical-physicals characteristics of the studied samples

No. Soil Sample	W%	Organic C	N- tot	P-tot	K-tot	Ca	Mg
	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	g/kg
1	2.91	0.28	213.87	241.33	171.63	0.566	145.987
2	3.34	1.77	829.06	271.14	357.74	0.580	127.855
3	5.45	2.12	498.81	241.33	445.46	4.139	37.942
4	5.77	1.30	350.36	271.14	394.27	7.454	38.632
5	4.07	1.24	283.55	666.11	206.87	1.475	101.443
6	3.14	11.49	768.09	801.04	329.41	2.362	71.718
7	4.22	1.91	551.85	498.66	703.65	6.184	33.312
8	3.20	1.60	855.34	579.44	509.14	2.814	116.401
9	6.29	1.58	668.60	2585.66	515.71	0.437	33.317
10	15.60	1.28	1435.97	369.10	446.38	2.892	117.084
11	6.81	4.61	2122.69	498.59	180.43	6.255	129.686
12	3.86	1.10	742.04	382.41	648.13	3.254	132.194
13	6.62	2.25	1355.95	426.00	1914.34	6.037	86.645
14	7.46	3.10	1783.93	740.78	2068.81	8.745	87.306
15	11.49	0.66	650.74	974.88	1434	5.759	103.446
16	4.92	1.66	1169.54	501.04	4960.33	4.475	573.308
Mean	**5.946805**	**2.3715432**	**892.5252**	**628.0406**	**955.3942**	**3.96425**	**121.0173**

RESULTS AND DISCUSSION

The chemical-physical characteristics of the studied samples varied greatly between them (table 1). The total contents of heavy metals of the studied samples are presented in Table 2. We compared the total content of heavy metals in the soil samples with international and German threshold values. The mean contents of Cd, Cr, Cu, and Ni were above the permissible limits of

the 86/278/EEC Directive (CEC 1986, BBodSchV (1999) and Average Earth Crust*. The mean contents of Pb were within values of international and German threshold values and the mean contents of Zn were above of permissible limits of Average Earth Crust*.

Table 2. Mean, international thresholds values, average earth crust (mg/kg) of heavy metals.

No. Soil Sample	Cd mg/kg	Cr mg/kg	Cu mg/kg	Ni mg/kg	Pb mg/kg	Zn mg/kg
1	7.545	120.415	947.73	84.02	7.502	99.593
2	6.876	91.439	1319.85	54.87	6.725	111.355
3	3.864	34.615	60.87	87.22	3.363	39.399
4	4.400	52.058	77.48	99.70	3.708	41.436
5	5.527	74.840	750.03	1.95	5.308	0.000
6	5.021	51.193	135.15	75.55	4.931	125.261
7	3.258	67.562	148.14	73.12	3.615	78.730
8	6.356	249.199	1571	492.80	10.957	336.407
9	4.774	329.547	75.7	388.27	9.426	69.074
10	6.425	1634.191	56.6	1732.54	4.390	76.981
11	5.160	932.096	47.05	1147.71	8.698	72.123
12	4.715	875.991	39.88	974.06	8.141	61.445
13	4.956	328.835	145.9	630.72	6.445	73.955
14	4.327	774.169	62.22	778.59	6.508	76.686
15	4.327	486.301	53.38	1252.56	2.961	71.823
16	3.048	82.468	76.98	111.03	5.073	77.297
Mean	**5.036204**	**386.55753**	**347.9975**	**499.0434**	**6.109406**	**88.22278**
86/278EECDirective[1]	3	150.000	140	75	300	300.000
BBodSchV[2]	1	60.000	40	50	70	150.000
Average Earth Crust*	0.98	85.000	25	44	17	71.000

[1]CEC (1986); [2]BBodSchV (1999); *Rudnick and Gao (2005) [7,8,9]

CONCLUSION

Although the industry has been inactive since 1990, the concentration of heavy metals is very high in the area for the four elements such as cadmium, copper, chromium and nickel.

It is necessary to make analyzes in surface waters or in deeper profiles to verify how the pollution has moved in the vertical direction.

The area should be rehabilitated as soon as possible to pave the way for the development of agricultural and cultural tourism, opening up jobs for the local population.

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SECTION SOCIO-ECONOMIC GEOGRAPHY

CONTEMPORARY GEOPOLITICAL AND DEMOGRAPHIC PROCESSES IN THE RAŠKA REGION AND THEIR IMPACT ON REGIONAL DEVELOPMENT

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ABSTRACT

The Raška region is located in the southwestern part of Serbia. The territory of the Raška region includes six municipalities in Serbia: Novi Pazar, Tutin, Sjenica, Prijepolje, Priboj and Nova Varoš. In addition, it includes the area of five municipalities in Montenegro: Pljevlja, Bijelo Polje, Berane, Petnjica and Rožaje. For the purposes of this work, the area belonging to Serbia was analyzed. It has an area of 4,504 km^2 and a total of 438 settlements.The geostrategic position of the Raška region has changed throughout history. It represents the historical core of the Serbian medieval state. The Serbian medieval state got its name from this region. That is why it has always had great importance from the political, demographic and economic point of view. The area of the Raška region represents a multi-ethnic environment, which is its basic demographic feature. The paper analyzes its geopolitical position, as well as demographic changes in the period 1991-2022. The population dynamic, natural changes of the population and the changes in the national structure were analyzed. Demographic processes in the region were influenced by several factors, the most important of which are settlement conditions, the level of economic development, and processes of urbanization and migration, especially in the rural-urban relationship. The Raška region has considerable natural potential that has not been adequately utilized for the purpose of economic development. Faster economic development will also condition the reduction of negative demographic processes, primarily emigration from rural areas.

Keywords: Raška region, Novi Pazar, depopulation, ethnic structure.

INTRODUCTION

The Raška region encompasses parts of southwestern Serbia and northeastern Montenegro. It is the territory where the first Serbian medieval state - Raška - was founded. That territory includes the area from river Tara in the south to mountains Golija, Javor, Čemernica, Murtenica and Zlatibor in the north and between the Drina river in the west and the Ibar river in the east. Administratively, the Raška region includes the territories of eleven municipalities, six of which are in Serbia (Priboj, Prijepolje, Nova Varoš, Sjenica, Novi Pazar and Tutin) and five in Montenegro (Pljevlja, Bijelo Polje, Berane, Petnjica[4] and Rožaje). This research is limited to the part of the region that belongs to Serbia.

Throughout history, the territory of this region has been the center of Serbian statehood, spirituality, prosperity, culture, and also the place where architecture, painting and literature

[4] The territory of today's municipality of Petnjica belonged to the territory of the municipality of Berane. With the new administrative division in Montenegro, it was separated as an independent municipality in 2013.

flourished. The importance of Raška in the Middle Ages is told by numerous cultural and historical monuments, among which the most significant are: the old town of Ras (the seat of Nemanja's medieval state from the 12th century), the Đurđevi stupovi monastery, the Sopoćani monastery, traces of Nemanjić dynasty in Deževa (the fountain and the foundations of the medieval church), Peter's church, the Mileševa monastery and the Banja monastery (St. Nicholas of Dabarski). Many of these endowments are included in the UNESCO list of world cultural heritage. During centuries of Ottoman empire's rule, the region was strongly influenced by their culture and Islam. As a consequence of the centuries-old rule of the Ottoman empire, the ethnic and religious structure of the population changed. By the decision of the Congress of Berlin in 1878, a Turkish administrative unit was formed on the territory of the medieval state of Raška – Sandjak of Novi Pazar[5]. Although this unit and term officially existed for only a few decades (until the liberation in the Balkan Wars of 1912-1913), the name "Sandžak" (or Sanjak) has remained in use to this day, especially among the Bosniak (Muslim) population (Павловић & Мишовић, 2007, Павловић & Мишовић, 2012).



Figure 1. Geographical position and administrative division of the Raška region, author: Krstić, F.

On the territory of Serbia, the Raška region has an area of 4,503 km^2 (5.1% of the territory of Serbia) within its administrative and municipal boundaries. According to the results of the last population census in 2022, 233,091 inhabitants lived in this region, which is a relative share of 3.5% of the total population of Serbia. With an average population density of 51.8 people/km^2,

[5] The term "sanjak" originates from the period of Turkish rule in Serbian and other Balkan lands. It denoted a smaller administrative unit in the Turkish administration, which existed throughout the Turkish Empire (Petrović, 1997). Sandžak as a geographical name should have disappeared from the Raška region with the end of Turkish rule, but it remained until the middle of the second decade of the 21st century.

the Raška region belongs to the sparsely populated regions of Serbia. There are 438 settlements in the region, of which 6 are urban. The largest number of highland and mountainous settlements (and even 4 out of 6 urban settlements) are affected by the depopulation process.

GEOSTRATEGIC POSITION

From a historical point of view, the geostrategic position of the Raška region has changed over time. That is why it has always had great importance in the wider region from a political, geographical, military-strategic and economic point of view. The changes that occurred through the historical development of the region are the result of socio-economic and historical-political circumstances in Serbia and Montenegro, but also in Southeast Europe (Гиговић, 2010, Павловић & Мишовић, 2012).

During the studied historical period of three decades (1991-2022), the geostrategic position and importance of the Raška region underwent significant changes. After Montenegro declared its independence in 2006, the place and importance of the Raška region changed significantly for both countries. In a geographical sense, this region no longer represents a compact geographical area, but is divided into a larger Serbian and a smaller Montenegrin part. The division of the territory caused the loss of the significance of the geostrategic position and gave it a peripheral role in both countries. In this way, the function of connecting neighboring and wider areas of the Balkan Peninsula is diminished (Павловић & Мишовић, 2007, Павловић & Мишовић 2012). These major geopolitical changes, along with complex socio-political circumstances, resulted in the geostrategic position of Raška becoming even more complex, sensitive and unfavorable during the first two decades of the 21st century.

The geostrategic position, in addition to influencing all spheres of life in the region, also has a great impact on regional development. This position of the Raška region is extremely complex and important in contemporary geopolitical circumstances. The complexity and importance of the position are considered from different aspects (Павловић & Мишовић 2012). The most important elements of the geostrategic position include:

- Peripheral position in relation to the entire territory of Serbia;
- Belonging to the western hilly-mountainous morphological unit, within the wider Dinaric region;
- Border area towards Montenegro and Bosnia and Herzegovina;
- Close proximity to the Ibar valley and Kosovo and Metohija;
- Absence of significant international roads;[6]
- Heterogeneity of the ethno-demographic structure of the population;
- The influence of various geographical factors on life in the region (especially the relief);
- Strategic mineral reserves and energy resources;
- Rich cultural and historical heritage;
- An economically underdeveloped part of Serbia;
- Importance from the aspect of defense for both countries (Serbia and Montenegro);

[6] There is a plan to build a highway that will connect Belgrade with the Montenegrin coast. Certain sections in Serbia and Montenegro have been completed, while the segment through the Raška region has been left for the final phase. In the region, the planned highway route is traced over the Pešter plateau, specifically through the territory of the municipality of Sjenica.

GEOPOLITICAL PROCESSES IN THE RAŠKA REGION

The geopolitical processes that affected the Raška region are complex and mutually conditioned. They come from Serbia's position in Southeast Europe (the Balkans) and the world. The Raška region within Serbia has a specific geopolitical position, which is a consequence of the region's peripheral position, heterogeneous ethnic structure, economic underdevelopment, etc. When analyzing geopolitical processes in the region, external factors (influence of other countries or international organizations), which have a great influence, must also be taken into account. Throughout history, this region has been the subject of interest for the former powers from the East and the West. On its territory, the influences of major regional powers were and are being refracted (Гиговић, 2010). Bearing in mind the natural and socio-geographic features of the Raška region, it has the role of a complex local and regional political factor in the area of Southeastern Europe, the Balkans and Serbia. The most significant and influential factors of the region's geopolitical position are the Islamic factor, whose role in this area is getting stronger, membership in the European Union and other international organizations and associations, the existence of crisis hotspots and numerous problems of an economic nature.

The border geographical position of the region, between potential conflict hotspots (Autonomous province of Kosovo and Metohija and Bosnia and Herzegovina - Republika Srpska) can have an impact on the Raška region and its regional development. In accordance with the current geopolitical processes in the environment, the Raška region can play the role of a stabilizing or destabilizing factor. This means that the Raška region could be a territory that unites or separates neighboring areas, or a territory that absorbs destabilizing impulses from the environment or spills those impulses onto neighboring areas (Мишовић & Ћурчић, 1996). Also, the connection between Serbia and Montenegro is carried out through the territory of the Raška region. As a result, it has a special significance. Its strategic importance was increased by the construction of the railway line Belgrade – Bar (in 1977) and the planned construction of the highway Belgrade – Boljari – Podgorica. The development of infrastructure and better traffic connections (within the region itself or with neighboring regions) would lead to faster economic development in this part of Serbia. This would slow down negative demographic processes, primarily the process of emigration, and affect the improvement of the economic standard. A more balanced regional development would also have an impact on better cohesive ties within the state.

DEMOGRAPHIC DEVELOPMENT

Contemporary demographic processes in the Raška region were influenced by several factors, the most important of which are: socio-historical features of the region, natural conditions of settlements, level of economic development, natural population growth, migration (emigration and internal rural-urban migration) and pronounced processes of deagrarization and urbanization. This region is characterized by a slower economic transformation, as well as slower changes in the economic, social and cultural features of the population. This caused the slower process of demographic transition compared to other parts of Serbia (Павловић & Мишовић, 2012). The highest population concentration is in the valleys and basins, where the

largest urban settlements were formed, while the most sparsely populated mountainous parts of the region are dominated by disperse and demographically small rural settlements (Павловић, 2019). In addition to the pronounced spatial differentiation of the population, the main demographic characteristic of the region is ethnic and religious heterogeneity and depopulation of rural areas. Contemporary demographic processes in this region are very complex. The most important aree: the change in the number of inhabitants, the natural increase of the populpation and the ethnic structure of the population. A comparative approach to the results of the census from 1991 to 2022 will enable the analysis of relevant indicators of the demographic state of the Raška region and indicate the possibilities of socioeconomic revitalization.

Population dynamic

The Raška region is included in the group of geographical regions of Serbia that are affected by an intensive process of depopulation. However, population dynamics in the mentioned time period were not continuous either spatially or temporally. In the period from 1991 to 2022, the total number of inhabitants of the Raška region decreased from 257,849 to 233,091, which is a decrease of 9.6%. The trend of decreasing population in the Raška region affected all municipalities, except for Novi Pazar, where the population increased by 25.2%. The largest relative decrease in the number of inhabitants was recorded in the territory of the municipality of Nova Varoš (-38.1%), followed by the municipalities of Priboj (-34.6%), Prijepolje (-30.8%), Sjenica (-28.5%) and Tutin (-4.6%) (Table 1). The main causes of the population decline in this period were the relatively low rate of natural increase and the negative migration balance. The Raška region is an area from which the population traditionally emigrates, but it is noticeable that the Bosniak-Muslim population is less mobile. For this reason, the main demographic features, as well as the movement of the population, show significant spatial differentiation. The population increase of the municipality of Novi Pazar, compared to other municipalities, indicates that the local economy managed to "sustain" itself during the turbulent decades. With such characteristics, it managed to attract the population from its immediate surroundings (Pešter plateau, Rogozna and Golija mountains). These processes caused the city of Novi Pazar to become a regional center.

Observed by inter-census periods, between 1991 and 2002, a sharp decline in the number of inhabitants of the Raška region was recorded (-8.6%). Drastic (geo)political and economic changes had a decisive influence on population dynamics. The last decade of the 20th century was marked by the breakup of Yugoslavia and the economic crisis. Many industrial facilities, which were the carriers of the economic development of the region, stopped working, due to which the population was forced to emigrate for economic reasons. Although the natural increase was relatively high, it could not compensate for the negative migration balance. The Serbian population mostly emigrated to the larger cities of Central Serbia (Belgrade, Kragujevac, Kraljevo, Čačak), and the Bosniak population to Bosnia and Herzegovina and the countries of Western Europe (to a much lesser extent to Turkey). In this period, negative demographic processes affected all municipalities, with the exception of Novi Pazar, where there was a slight increase in the population.

Table 1. Number of inhabitants in Raška region (1991-2022)

Municipality	Census				Change 1991-2022	
	1991	2002	2011	2022	Num.	%
Nova Varoš	21,812	19,982	16,638	13,507	-8,305	-38.1
Priboj	35,951	30,377	27,133	23,514	-12,437	-34.6
Prijepolje	46,525	41,188	37,059	32,214	-14,311	-30.8
Sjenica	33,681	27,970	26,392	24,083	-9,598	-28.5
Novi Pazar	85,249	85,996	100,410	106,720	+21,471	+25.2
Tutin	34,631	30,054	31,155	33,053	-1,578	-4.6
Raška region	257,849	235,567	238,787	233,091	-24,758	-9.6

Source: https://data.stat.gov.rs (Accessed: 5.3.2024)

During the first decade of the 21st century, there is a certain stabilization of socioeconomic living conditions. This had a positive effect on the dynamic of the total population. In the period from 2002 to 2011, the population of the Raška region increased by 1.4%. However, at the municipal level, the formation of zones with different demographic characteristics and the intensity of population growth or decline can be observed. An increase in the number of inhabitants was achieved in the municipalities of Novi Pazar by 16.8% and Tutin by 3.7%, while in the municipalities of Priboj and Nova Varoš, a decrease in the number of inhabitants was recorded by 10.7% and 16.7%, respectively (Table 1). To a significant extent, this is conditioned by the faster decline of natural growth in municipalities with a dominant Serbian population.

In the last intercensal period (2011-2022), the region experienced depopulation again by -2.4%. At the municipal level, this period is characterized by similar demographic tendencies. The trend of population decline in depopulated municipalities became more pronounced. The decline in the number of inhabitants ranged from -18.8% in Nova Varoš to -8.7% in Sjenica. The municipalities of Novi Pazar and Tutin continue to experience an increase in the number of inhabitants during this inter-census period (Table 2). However, the population growth in these municipalities was recorded by the urban settlements of Novi Pazar and Tutin and their suburban settlements, while the largest part of the rural area continued to lose its population.

The depopulation of the Raška region is largely the result of emigration of the young and workforce population, but also due to the negative natural increase in the Serbian population. Population migration, especially economic ones, cannot be prevented without creating optimal conditions that will enable young people to see their future and perspective in the region. The decrease in the number of inhabitants directly affects the decrease in the workforce in the Raška region. This is especially noticeable in rural households, because the depopulation affected rural settlements the most. This has a negative impact on economic development. The old rural population is unable to engage in animal husbandry, and in recent times, fruit growing (raspberry plantations are being planted in the vicinity of Novi Pazar, Nova Varoš and Priboj). In addition, a large number of natural potentials of the Raška region have not been economically used, so that they could influence a more balanced regional development, and thus slow down migration flows, primarily in the rural-urban relationship.

Natural changes of population

The natural changes of population in the Raška region are a consequence of the socio-economic characteristics of the region and uneven regional development. This demographic indicator has undergone significant changes in the period from 1991 to 2022. At the regional level, the birth rate in this period decreased from 18.6‰ to 13.8‰. However, differences in the intensity of natural changes of population are observed at the municipal level. In 1991, the birth rate was high in the municipalities of Novi Pazar (21.5‰), Tutin (21.5‰), and Sjenica (20.2‰), which have a Bosniak majority population, while it was moderate in the municipalities of Prijepolje (15.6‰), Priboj (14.6‰), and Nova Varoš (12.9‰). In census years, the number of live births, as well as the birth rate, mostly declined in most municipalities, except in Tutin and Novi Pazar. At the beginning of the 21st century, the birth rate was moderate or low in all municipalities of the Raška region. Despite the dominant process of demographic transition, a slight increase in the birth rate was recorded in the last intercensal period (2011 – 12.5‰; 2022 – 13.8‰). The slight increase in the birth rate and the number of live births in 2022 is explained by the fact that this was a compensatory year, due to reduced birth rates, or postponement of births, during the first and second years of the coronavirus pandemic. An increase in the birth rate was recorded in municipalities with a Bosniak majority, which maintained moderate rates (Tutin – 18.3‰, Novi Pazar – 16.1‰, and Sjenica – 14.8‰). Municipalities with a Serbian majority also experienced an increase (Nova Varoš – 2011 – 5.4‰; 2022 – 7.1‰) or a slight decrease compared to previous periods (Table 2).

Table 2. Natural population movement of the Raška region from 1991 to 2022 (‰)

Municipality	1991			2002			2011			2022		
	B	M	NG	B	M	NG	B	M	NG	B	M	NG
Nova Varoš	12.9	9.4	3.5	7.1	11.2	-4.1	5.4	14.7	-9.3	7.1	20.3	-13.1
Priboj	14.6	6.6	8.0	11.0	9.4	1.6	6.4	11.6	-5.2	5.9	15.7	-9.9
Prijepolje	15.6	8.4	7.2	12.7	11.7	1.0	9.9	12.5	-2.6	9.3	14.0	-4.7
Sjenica	20.2	6.1	13.9	15.7	7.9	7.8	11.9	9.9	2.0	14.8	13.6	1.2
Novi Pazar	21.5	6.8	14.7	18.9	7.8	11.1	15.1	8.0	7.1	16.1	7.9	8.2
Tutin	21.5	5.1	16.4	22.4	6.9	15.5	17.4	7.4	10.1	18.3	7.5	10.8
Raška region	18.6	7.0	11.6	15.9	8.9	7.0	12.5	9.7	2.8	13.8	10.8	3.0

B – Birth rate; M – Mortality rate; NG – Natural growth rate

Source: https://data.stat.gov.rs (Accessed: 5.3.2024)

During the period from 1991 to 2022, the mortality rate of the population of the Raška region showed a constant slight increase. The mortality rate in this period increased from 7.0‰ to 10.8‰. At the beginning of the observed period, the mortality rate of all municipalities was low (Tutin – 5.1‰; Nova Varoš – 9.4‰). Since the beginning of the 21st century, the population's mortality rate has gradually assumed moderate rates, especially in municipalities with a Serbian majority. Differences in the mortality rate of the population of individual municipalities were increasing, due to different models of reproductive behavior of individual ethnic communities (Vlahović, 1997, Pavlović & Mišović, 2012). The increase in mortality is the result of depopulation and demographic aging of the population of the Raška region, conditioned by the emigration of younger, working-age population and longer life expectancy. Until 2022, low mortality rates were characteristic only of the municipalities of Tutin (7.5‰) and Novi Pazar (7.9‰), while it was high in the municipality of Nova Varoš (20.3‰). In the municipalities of Tutin and

Novi Pazar, there was a slight change in the mortality rate from 2011 to 2022 (Table 2). The stagnation of the population's mortality in these municipalities is a consequence of the slower process of demographic aging.

Due to the decline in the birth rate and the increase in mortality, the population of the Raška region is characterized by a tendency of a decline in natural growth. At the turn of the 20th to the 21st century, the decline in the natural growth rate was intensive (1991 – 11.6‰; 2011 – 2.8‰), but in the last intercensal period, there was stabilization and a slight increase (2022 – 3.0‰). When observed by municipalities, the values of this demographic indicator vary significantly. At the end of the 20th century, all municipalities recorded a positive natural growth, but it was low in Nova Varoš (3.5‰), while relatively high in Tutin (16.4‰). In the following period, the natural growth rate decreased most rapidly in the municipalities of Nova Varoš, Priboj, and Prijepolje, and the values became negative. According to the latest data from 2022, the natural growth rate is still positive in municipalities with a Bosniak majority population. In the municipality of Sjenica, the natural growth rate is low (1.2‰), and moderate to high in the municipalities of Novi Pazar (8.2‰) and Tutin (10.8‰) (Table 2). These data indicate that the process of demographic transition in the southeastern part of the Raška region started later than in the northwest part of the region, as well as the rest of Serbia.

Changes in the ethnic structure of the Raška region

Multi-ethnicity, or heterogeneous ethnic structure, is an important factor in demographic processes in the Raška region. The ethnic structure of the region has been influenced by various historical, socio-economic, and political factors. In the period from 1991 to 2022, significant changes in the ethnic structure did not occur in the region. Unlike other parts of the former Yugoslavia, and even Serbia, this area was spared from war events and violent migrations. As a result, changes in the ethnic structure are the consequence of different natural movements and economic migrations of the population.

On the studied territory, three municipalities have consistently been predominantly inhabited by Serbian population during all censuses – Nova Varoš, Priboj, and Prijepolje. On the other hand, three municipalities in the southeastern part of the region are predominantly populated by Bosniak population – Tutin, Novi Pazar, and Sjenica. By analyzing the data on ethnic structure, it is noticed that there has been a decrease in the share of Serbian population in the region. The share of Serbs at the level of the entire region was 37.1% in 1991, and 26.8% in 2022. On the other hand, the share of Bosniak population increased from 60.3% to 64.8% . Looking at the absolute numbers, the number of Serbian population decreased from 89,396 to 62,478 for the period 2002 – 2022. The number of Bosniak population increased from 134,131 to 150,941 for the period 2002 – 2022. In the same period, the number of Muslim population decreased from 8,222 to 6,427. It should be noted that changes in this category occur due to demographic processes, but also due to different declarations of the population, i.e., subjective reasons. The share of population declaring themselves as Muslims in 2022 in the region is 2.7% (Table 3).

Analyzing the data at the municipal level, there is evident decrease both in absolute number and share of Serbian population for the last intercensal period 2011 – 2022 in all territorial units of the region. In 2022, the smallest share of Serbs in the region is in the municipality of

Tutin (2.1%), while the largest is in the municipality of Nova Varoš (88.1%). Accordingly, the largest share of Bosniak population in the region is precisely in the municipality of Tutin (92.0%), while the smallest is in the municipality of Nova Varoš (5.0%) (Table 3).

Table 3. Ethnic structure of the Raška region in 1991 and 2022

Municipality	1991									
	Serbs		Bosniaks		Muslims		Other		Unknown	
	Num.	%	Num.	%	Num.	%	Num.	%	Број	%
Nova Varoš	19,284	88.4	/	/	1,857	8.5	632	2.9	39	0.2
Priboj	23,421	65.1	/	/	10,927	30.4	1,573	4.4	30	0.1
Prijepolje	24,770	53.2	/	/	20,200	43.4	1,513	3.3	42	0.1
Sjenica	7,546	22.4	/	/	25,633	76.1	425	1.3	77	0.2
Novi Pazar	19,064	22.4	/	/	64,251	75.4	1,665	2.0	269	0.3
Tutin	1,461	4.2	/	/	32,672	94.3	374	1.1	124	0.4
Raška region	95,546	37.1	/	/	155,540	60.3	6,182	2.4	581	0.2
Municipality	2022									
	Serbs		Bosniaks		Muslims		Other		Unknown	
	Num.	%	Num.	%	Num.	%	Num.	%	Num.	%
Nova Varoš	11,901	88.1	673	5.0	308	2.3	276	2.0	349	2.6
Priboj	16,909	71.9	4,144	17.6	914	3.9	404	1.7	1,143	4.9
Prijepolje	14,961	46.4	12,842	39.9	1,945	6.0	766	2.4	1,700	5.3
Sjenica	3,861	16.0	17,665	73.4	1,069	4.4	381	1.6	1,107	4.6
Novi Pazar	14,142	13.3	85,204	79.8	1,851	1.7	1,732	1.6	3,791	3.6
Tutin	704	2.1	30,413	92.0	340	1.0	190	0.6	1,406	4.3
Raška region	62,478	26.8	150,941	64.8	6,427	2.8	3,749	1.6	9,496	4.1

Source: Попис становништва и домаћинстава СР Југославије 1991. године – Становништво према националној припадности. Национална припадност, књига 3. Савезни завод за статистику, Београд, 1993, Попис становништва, домаћинстава и станова 2022. Национална припадност по општинама и градовима, књига 1. Републички завод за статистику, Београд, 2023

The municipality of Novi Pazar, as the regional and economic center of the region, deserves special analysis. Approximately half of the total population of the region lives in its territory. Due to positive natural increase but also migration from other municipalities of the region, the number of Bosniak population constantly grows in Novi Pazar (2002 – 65,569; 2022 – 85,204). On the other hand, the number of Serbian population in the same period significantly decreased due to negative demographic processes (2002 – 20,465; 2022 – 13,251). The Serbian population in rural settlements of the municipality of Novi Pazar has a particularly unfavorable age structure, which contributes to the intensive process of depopulation.

CONCLUSION

Socio-geographical processes in the Raška region have played a significant role in shaping and directing geopolitical processes that have influenced not only Serbia but also the wider Balkan Peninsula. Contemporary geopolitical and demographic processes in the Raška region have a negative impact on the regional development of the region. Under the influence of these processes, there has been uneven distribution of population and economic objects in the region. This uneven relationship between natural potentials and population concentration has resulted in an intensive process of emptying rural areas and the "demographic dying" of a large

number of rural settlements in the region. In addition, there is an increase in the number of elderly and single households, which are also on the verge of extinction.

The peripheral geostrategic position of the region in Serbia, the proximity to Kosovo and Metohija as a politically unstable part of Serbia, weaker internal traffic connectivity, and distance from major international traffic routes have led to the regional development being greatly influenced by changes on the political, economic, military, and international level. Also, such geostrategic factors have put the Raška region in an unfavorable position for attracting foreign capital. However, the completion of the highway, whose route passes through the Pešter plateau, will significantly improve the traffic and economic position of the region. This will "open up" the area and connect it with neighboring regions (Central Serbia, Montenegro's mountainous region, and Montenegrin coast), resulting in faster economic development. All this will affect a more balanced regional development of the region and the inclusion of economically most underdeveloped parts in modern economic flows (development of agriculture, livestock farming, fruit growing, tourism, industry, etc.). In order to achieve a more balanced regional development, it is necessary to start and complete the production cycle at the regional level.

In modern geopolitical and demographic processes, the region whose main features are a complex and relatively unfavorable geostrategic position, economic underdevelopment, depopulation, emigration and heterogeneous ethno-demographic population structure has unfavorable conditions for faster socioeconomic progress. Due to the complex geopolitical and demographic reality, coordinated actions between different levels of government and social structures are necessary. In this way, existing challenges that limit its development would be adequately answered and natural and cultural-historical potentials would be used for faster and more even regional development.

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THE ANALYSIS OF THE ETHNIC DIVERSITY CHANGES IN NORTH MACEDONIA

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ABSTRACT

Studying ethnic diversity and ethnic segregation is becoming increasingly important in ethnically heterogeneous societies, as ethnic diversity forms the backbone of minority policies in these countries. North Macedonia has witnessed a rise in ethnic heterogeneity evident in the growing number of ethnic groups and modalities recorded in recent censuses. This study explores the dynamics of ethnic diversity and segregation at smaller territorial levels, emphasising disparities between urban and rural areas, during the period between the 1994 and 2021 censuses. Additionally, the paper examines the impact of various socio-historical, socio-economic, and demographic factors on these dynamics. The analysis of the research will be based on the application of the entropy index, which shows the spatial variability of diversity and the interaction between different ethnic groups. The outcome of this research provides a deeper insight into dynamics of ethnic diversity at a small spatial scale and the factors that have contributed to it..

Keywords: ethnic diversity, ethnic segregation, multiethnic societies, entropy index, North Macedonia.

INTRODUCTION

Research into ethnic diversity is becoming increasingly important in developed societies especially due to the considerable increase in migration flows. This is reflected in the increasing number of studies on this topic, as the managing growing ethnic diversity requires the promotion of inclusivity, respect for diversity and the resolution of potential inter-ethnic conflicts (Mägi et al, 2016; Kauppinen, van Ham, 2018). Reviewing the literature on this topic suggests that ethnic diversity is a complex phenomenon and that the occurrence of ethnic segregation appears in different social settings. Significant changes in society can be observed in the United States of America, which today is one of the most racially and ethnically diverse environments. Around the year 2000, immigration to the USA accounted for almost a third of the total population growth in the USA. This immigration trend had a profound impact on intensifying the racial and ethnic heterogeneity of American society (Frey, 2011). Coleman (2006) considers that the process of the third demographic transition is already taking place on the territory of the USA, since population growth is achieved exclusively on the basis of a positive migration component, while in some scientific circles there is already talk of a potential fourth demographic transition (Frey, 2015). This indicates the geographical distribution of ethnic minorities, i.e. immigrants from the primary places of immigration to new destinations in other parts of the

country. It implies the final stage of ethnic transition, i.e. the possible occurrence of ethnic substitution of the population.

In addition to the USA, many European countries are also met with the process of ethnic diversification and ethnic segregation of society. Great Britain is often characterised by a marked diversity, inhabited by a considerable number of different ethnic and racial groups. This phenomenon is particularly evident in urban areas, where the proportion of ethnic communities has increased significantly in recent decades as a direct result of the ethnically diverse population migration that has impacted all major cities in the UK (Catney, 2015; Catney, 2018). As part of the project "Residential segregation in five European countries - A comparative study using individualised scalable neighbourhoods" (project ResSegr, 2015-2019), several studies have examined the stratified intersection of ethnic diversity, segregation and socio-economic inequality in Belgium, Denmark, the Netherlands, Norway and Sweden. Andersson et al. (2018) report that there are no significant differences in urban ethnic segregation patterns among non-European migrants between Belgium, Sweden, Denmark and Norway. Another conclusion of this research is that non-European migrants are not only concentrated in areas that are predominantly inhabited by migrants, but that they are dispersed across these countries.

Costa and de Valk (2018) conclude that in the urban agglomerations of Brussels, Antwerp and Liège in Belgium, there has been a spatial isolation of poor and economically disadvantaged migrant groups who inhabit these cities in greater concentrations, which is particularly pronounced in Brussels. Malmberg et al. (2018), who analysed ethnic segregation in Sweden, concluded that despite the increase in settlements inhabited only by migrants of non-European origin and mostly located in metropolitan areas, there has been no increase in the level of segregation. Kauppinen and van Ham (2018) conducted a longitudinal study of the population of Helsinki, in which they observed the different effects of various demographic factors on the occurrence of residential segregation in the ethnically very diverse capital of Finland. They conclude that intra-regional population migration played a crucial role in the emergence of segregation, and the study found that there was no general tendency towards self-segregation. Mediterranean countries such as Italy, Greece and Spain, which face a significant influx of migrants, are most likely to experience social and housing deprivation in the larger urban centres, which are the main immigration destinations. According to one study, residential segregation is a consequence of the social marginalisation of this population group (Malheiros, 2002).

The ethnic diversity of the Balkans, a traditionally ethnically heterogeneous region, has been little studied in the literature. Most works deal with the issue of ethnic diversity in the context of fulfilling human and minority rights, integration, interethnic relations and tensions, improving dialogue in ethnically diverse societies, etc. (Žagar, 2010; Skendaj, 2016). Other research has examined the impact of interethnic prejudice on the emergence of ethnic tensions, ethnic segregation and living in enclaves (Kunovich, Hodson, 2016). Some other authors have focussed on examining the relationship between ethnic diversity and the economic development of states (Hysa, 2020). An extremely small number of studies have focussed on the influence of demographic factors on the process of ethnic diversification and ethnic segregation of the population (Hammel et al, 2010). In the context of North Macedonia, most of the papers analysed the ethnic environment, ethnic distance and multiculturalism (Simoska, 2012) and

cultural diversity in public spaces (Mojanchevska, 2018). This study explores the dynamics of ethnic diversity and segregation at smaller territorial levels, emphasising disparities between urban and rural areas, during the period between the 1994 and 2021 censuses. Additionally, the paper examines the impact of various socio-historical, socio-economic, and demographic factors on these dynamics. The analysis of the research will be based on the application of the entropy index, which shows the spatial variability of diversity and the interaction between different ethnic groups.

DATA AND METHODS

This paper uses entropy index (diversity score) to assess the dynamics of ethnic diversity in North Macedonia for two main reasons. First, this is a multi-group metric which, unlike many other methods, assess ethnic diversity of spatial units by considering more than two ethnic groups. This is particularly suited for analysing multiethnic societies like North Macedonia, where non-dominant ethnic groups constitute nearly 40% of the population.

Second, the entropy index is a rare spatial measure, providing results on disaggregated spatial units that account for the inherent heterogeneity of ethnic geography. In contrast, most measures are aspatial, presenting aggregated results for entire regions and overlooking intraregional differences in ethnic structure, which are “the norms rather than the exceptions” in most cases (Wong, 2002). Focusing solely on regional or national levels makes it impossible to comprehend intraregional ethnic differences and changes. This is especially relevant for North Macedonia, where the geography and dynamics of ethnicities, as well as the ethnic composition of settlements, vary widely across the country.

Entropy index measures the level of ethnic diversity in each settlement based on its ethnic composition. The entropy index (E) is calculated as follows:

$$E = \sum_{m=1}^{M} (p_m) ln \left(\frac{1}{p_m}\right)$$

Where M is the total number of ethnic groups, pm represents the proportion of ethnic group m in the country, and ln denotes the natural logarithm. When all inhabitants of a settlement belong to a single ethnic group, diversity is minimal (no diversity at all), and the entropy index is 0. The diversity score is maximized when settlement inhabitants are equally distributed across ethnic groups.

The entropy score is influenced by changes in the number of ethnic groups considered in the study (Barros & Feitosa, 2018; Peach, 2009). By a rule, assuming equal distribution among groups, the more ethnic groups you take into the account, the higher entropy index you get (Hammel et al., 2010). Therefore, the choice of the (consistent) number of groups is crucial when dealing with temporal changes in ethnic diversity to ensure comparability across different years. The Macedonian Census in 1994 at the settlement level reported data for six ethnic groups and a residual group - "others", while the later censuses introduced Bosniaks as an additional group. For this analysis, the authors opted to use all six ethnic groups from the 1994

census, and six largest groups from 2021 census which led to the authors merged Vlahs from the last census with the "others" category.

GENERAL DEMOGRAPHIC TRENDS IN NORTH MACEDONIA

After a slight increase in the number of inhabitants in the 1994-2002 census period, when the country recorded over 2 million inhabitants, there followed a significant decline in the number of inhabitants to 1,836,713 in 2021. North Macedonia has faced severe demographic erosion in recent decades due to declining natural growth rates and lower fertility rates in the country's regions (Madjevikj et al, 2016). The total fertility rate has changed significantly, falling from 2.2 to 1.59 children per woman between 1994 and 2002 (Dragović, 2009). The recent period has been characterised by a further decline in the birth rate, and the TFR dropped to 1.44 children per woman around the 2021 census (Eurostat, 2024). If we also observe the migration processes that took place at the end of the 20th and beginning of the 21st century, it can be concluded that they reflect a turbulent time, especially after North Macedonia gained independence. Political instability and tensions in the Balkan region initiated massive migration flows in and out of North Macedonia. During this time, a large proportion of immigrants (and refugees) came to North Macedonia from the former Yugoslav republics, particularly from Serbia (especially from Kosovo and Metohija), Croatia, Bosnia and Herzegovina and Montenegro. Immigrants from Albania and Turkey were also notable. These migration flows have influenced the deepening of ethnic heterogeneity in certain parts of the country (Apostolovska Toshevska et al, 2018). Recent migration processes indicate a significant emigration of the population from Macedonia mainly due to economic instability of the country (Apostolovska Toshevska et al, 2017).

Table 1. Population characteristics and changes in the settlements of North Macedonia

Population size	Settlements				S hare of total population		Population change (1994-2021) (No)		
	No		%						
	1994	2021	1994	2021	1994	2021	Growth	No changes	Decline
>100000	1	1	0,06	0,06	22.10	25.60	1	-	-
50001-100000	4	4	0,23	0,23	13.66	14.78	1	-	3
20001-50000	8	8	0,46	0,46	14.21	14.34	1	-	7
5001-20000	25	19	1,43	1,09	11.27	10.03	6	-	13
1001-5000	214	174	12,26	9,97	21.60	20.36	57	-	117
501-1000	231	173	13,23	9,91	8.67	7.13	43	-	130
101-500	567	466	32,47	26,69	7.31	6.68	54	1	411
21-100	375	307	21,48	17,58	1.09	0.89	13	-	294
< 20	201	378	11,51	21,65	0.10	0.18	32	5	341
Uninhabited	120	216	6,87	12,37	0.00	0.00	-	108	108
Total	1746	1746	100,00	100,00	100.00	100.00	208	114	1424

Source: Author's calculation based on data from the Census of Population, Households and Dwellings in the Republic of North Macedonia, 2021

In terms of population, the settlement network of North Macedonia is dominated by Skopje (with 25.6% of the total population of North Macedonia), which is the only settlement with more than 100,000 inhabitants and more than six times the size of the second largest settlement,

Kumanovo. Kumanovo, Bitola, Tetovo and Prilep belong to the group of settlements with more than 50,000 inhabitants, followed by 8 settlements between 20,000 and 50,000 inhabitants (Štip, Veles, Ohrid, Gostivar, Kavadarci, Strumica, Kočani and Kičevo). These settlement groups comprise almost 55% of the total population of North Macedonia and were the only ones that remained constant in terms of associated settlements during the observed period (1994-2021) and the only ones whose share of the total population increased during this period (Table 1). However, population growth was not evenly distributed among them. While Skopje, Tetovo and Kvadraci experienced population growth, the number of inhabitants in the remaining 10 settlements with more than 20,000 inhabitants decreased (Figure 1). In the following four groups, comprising settlements with between 100 and 20,000 inhabitants, a decline in the number of settlements and the number of inhabitants was observed. In the group with fewer than 20 inhabitants and in the group of uninhabited settlements, on the other hand, the number of settlements increased significantly (Table 1). All this points to the widespread process of population decline in the settlements, which has already affected 82% of the settlements. Population growth was observed in 208 settlements, most of which are located in the Skopje region, which further emphasises the existing regional imbalances (Table 1; Fig. 1).

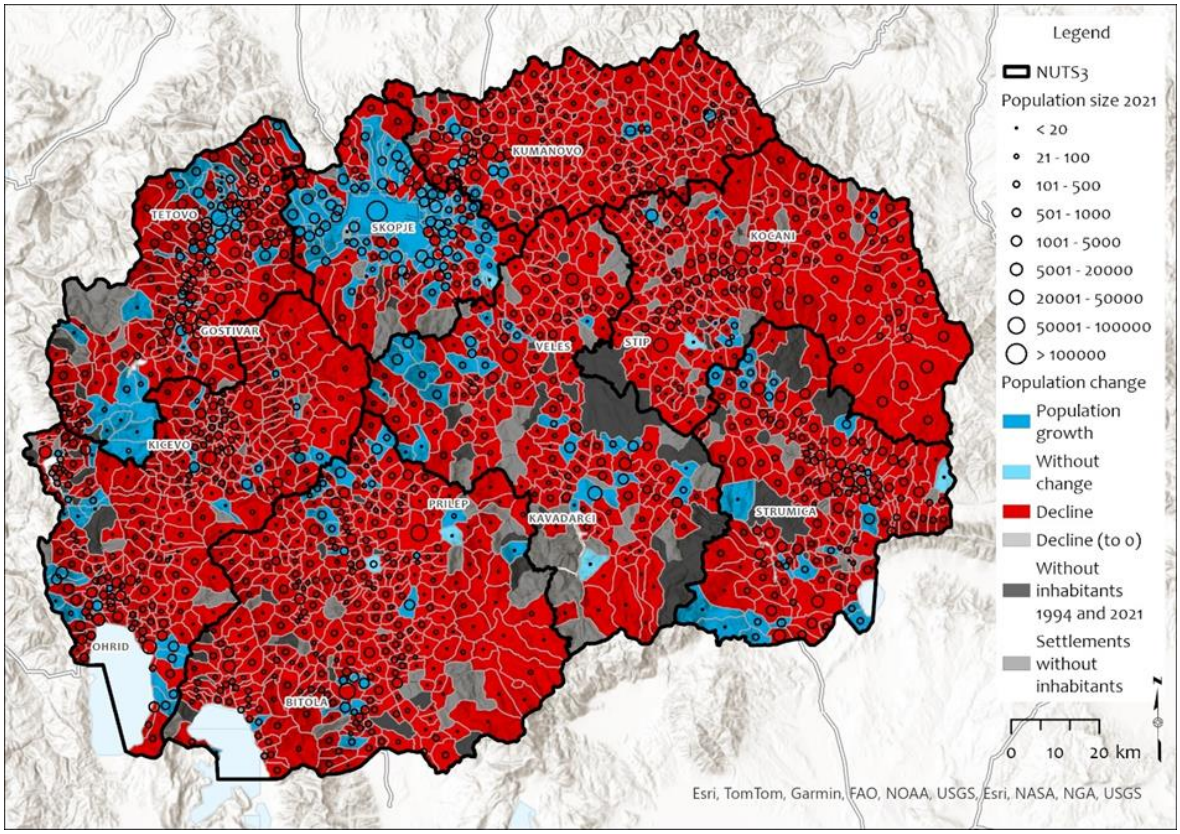

Figure 1. Population size and changes in the settlements of North Macedonia
Source: Created by the authors.

RESULTS AND DISCUSSION

Ethnic diversity analysis at the settlement level for the 2021 census reveals substantial regional disparities (Figure 2; Table 2). Regions with high diversity are concentrated in the densely populated northern parts of North Macedonia, particularly between the capital city Skopje and

Kumanovo, and to a lesser degree, in the upper Vardar River valley between Tetovo and Gostivar. Additionally, areas with higher diversity include the Vardar River valley (Gradsko – Negotino – Demir Kapija) a major transportational artery, the Western border regions near Crni Drim and Radika valley and around Lake Prespa and Bitola, an area historically inhabited with different ethnic minorities. "Islands" of higher ethnic diversity are found around some larger urban settlements such as Kicevo, Stip, and Strumica. However, North Macedonia also has a high number of monoethnic settlements (settlements with 0 entropy) and settlements with higher shares of just one ethnicity. These are predominantly situated in rural, higher altitude and less populated areas on both sides of the Vardar valley.

Table 2. Ethnic diversity of settlements in North Macedonia by size; Source: Created by the authors.

Population size	Monoethnic settlements (No)		Entropy index in 2021 (% settlements)					Median for entropy index	
	1994	2021	< 0.05	0.05-0.15	0.15-0.25	0.25-0.4	>0.4	1994	2021
> 20000	0	0	-	-	7,7	30,8	23,1	0,241	0,3
5001-20000	0	0	-	5,3	42,1	15,8	10,5	0,146	0,152
1001-5000	28	20	11,5	43,7	15,5	6,3	14,4	0,027	0,037
501-1000	59	31	17,9	39,3	16,2	5,8	10,4	0,019	0,03
101-500	261	132	28,3	33,7	17,0	5,6	8,6	0,011	0,031
21-100	267	189	61,6	7,2	17,3	4,2	7,8	0	0
< 20	177	332	87,8	-	3,7	4,2	3,2	0	0
Total (No)	792	704	324	210	83	124	85	0	0

Source: Author's calculation based on data from the Census of Population, Households and Dwellings in the Republic of North Macedonia, 1994-2021

This paper analysed ethnic diversity changes based on data from the 1994 and 2021 censuses (Table 3; Figure 3 and 4). The findings suggest a slight overall increase in ethnic diversity (from 0.515 to 0.536) during the study period. This increase can be primarily attributed to a significant decrease in the ethnic Macedonian population, which accounted for around 90% of the total decline in North Macedonia, alongside stagnation or modest growth among certain ethnic minority groups (e.g., Albanians and Roma). However, the changes in diversity at the settlement level were much more complex. A decrease in entropy was observed in 426 settlements (190 of which became monoethnic), while entropy increased in 590 settlements. In 2021, there were 704 monoethnic settlements, slightly fewer than in 1994 (792 settlements).

The changes in ethnic diversity manifest more complexity when examining settlements through their demographic characteristics. Generally, ethnic diversity increased more in settlements that experienced population growth, compared to a larger number of smaller and depopulating settlements. This indicates that in the settlements with positive demographic changes, population increase tended to have a more heterogeneous than the population structure of the settlement.

However, a more nuanced understanding occurs when comparing population dynamics with ethnic diversity changes. We identified four different groups of settlements based on population and diversity dynamics. The first group comprises settlements with positive demo-

graphic and entropy changes, which are spatially and demographically diverse. These settlements, mostly ranging from 100 to 5000 inhabitants, include the capital city of Skopje and exhibit dispersed spatial patterns, with an exception of few settlements adjoining Skopje.

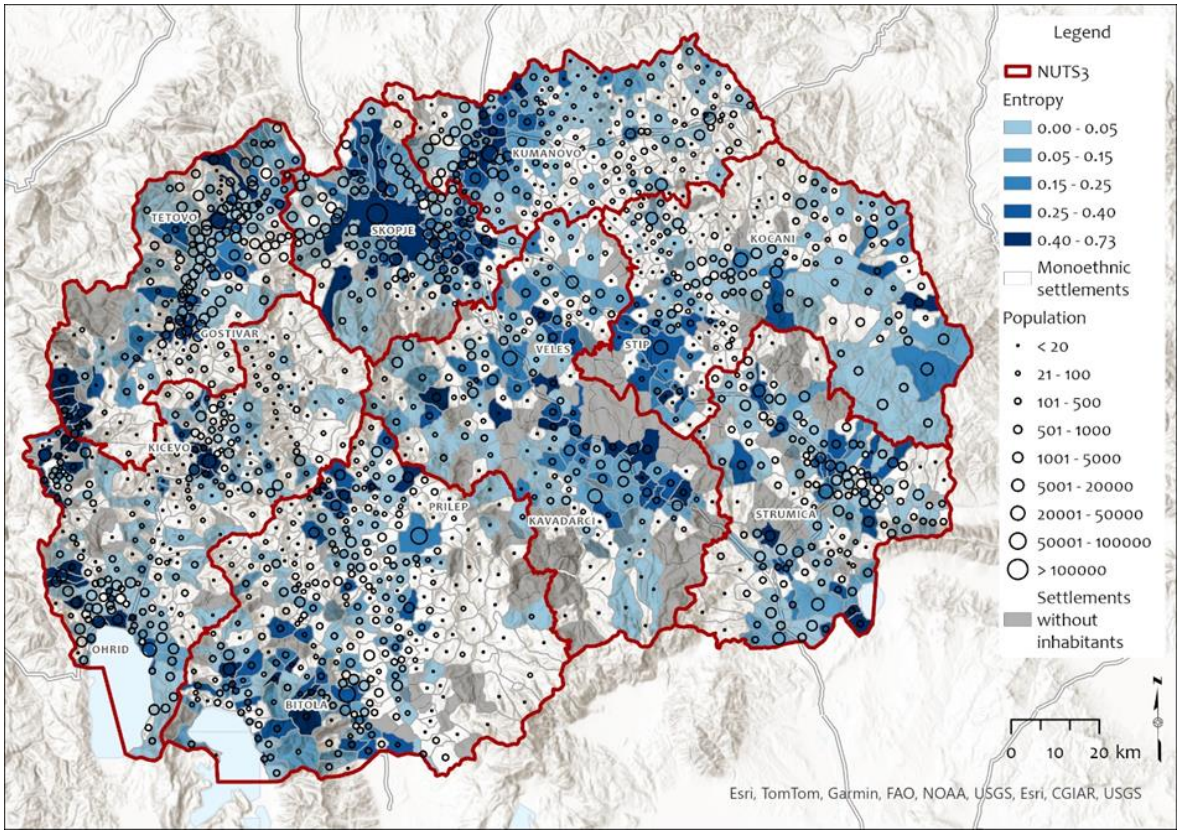

Figure 2. Ethnic diversity and size of settlements in North Macedonia, 2021
Source: Created by the authors

Table 3. Ethnic diversity and population changes in North Macedonia (1994-2021)

Population size	Entropy growth - Population growth		Entropy growth - Population decline		Entropy decline - Population growth		Entropy decline - Population decline		Monoethnic		Total
	No	%	No	%	No	%	No	%	No	%	No
>100000	1	100,0	-	-	-	-	-	-	-	-	1
50001-100000	-	-	3	75,0	1	25,0	-	-	-	-	4
20001-50000	1	12,5	7	87,5	-	-	-	-	-	-	8
5001-20000	3	15,8	10	52,6	3	15,8	3	15,8	-	-	19
1001-5000	25	14,4	64	36,8	24	13,8	41	23,6	20	11,5	174
501-1000	23	13,3	74	42,8	10	5,8	35	20,2	31	17,9	173
101-500	29	6,2	209	44,8	15	3,2	81	17,4	132	28,3	466
21-100	8	2,6	93	30,3	-	-	17	5,5	189	61,6	307
< 20	7	1,9	33	8,7	1	0,3	5	1,3	332	87,8	378
Uninhabited	-	-	-	-	-	-	-	-	-	-	216
Total	97	5,6	493	28,2	54	3,1	182	10,4	704	40,3	1746

Source: Author's calculation based on data from the Census of Population, Households and Dwellings in the Republic of North Macedonia, 1994-2021

Population and diversity growth in these settlements are primarily driven by ethnic minorities. In the second group, entropy increased while the population declined. This group is

the most numerous, encompassing almost one-third of all inhabited settlements in North Macedonia. These settlements are mostly located in regions where Macedonians constitute the majority of the population, notably in the Eastern and South-eastern regions. The increase in diversity is mainly attributed to negative demographic trends, particularly among the Macedonian population. These settlements comprise primarily smaller settlements (with populations ranging from 100 to 500 inhabitants) but also include larger urban centers such as Kumanovo, Bitola, Prilep, Stip, Veles, Ohrid, and Gostivar, among others.

The third group consists of a few settlements with positive population change but declining diversity. Here, the dominant ethnic group grew more than the rest, resulting in a reduction of ethnic diversity. These settlements, above average in size (with Tetovo being the only larger settlement), are mostly located next to larger urban areas. Lastly, the fourth group comprises settlements with negative changes in both population and diversity during the study period. In most cases, all ethnic groups experienced population decline, with minorities declining more than the dominant ethnicity. These settlements, characterized by a dispersed spatial pattern, exhibit some "spatial affinity" towards the Skopje region and upper Vardar valley.

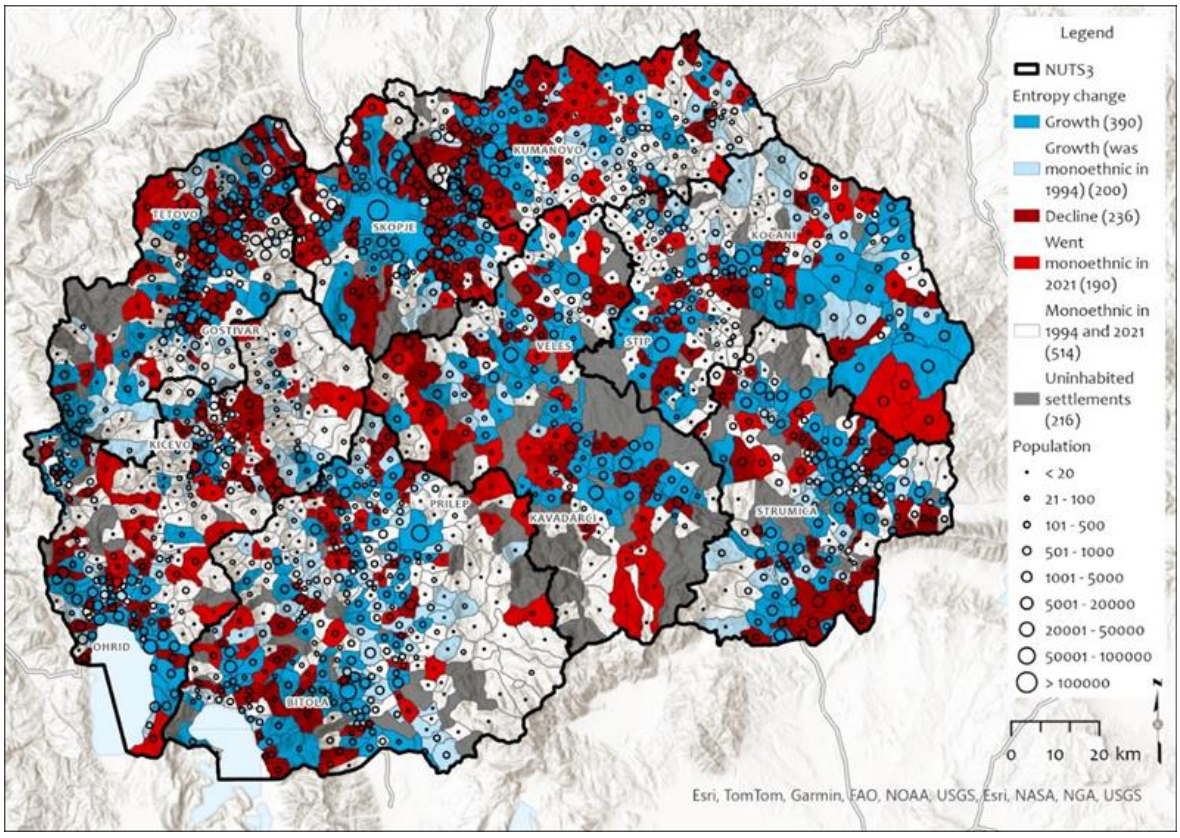

Figure 3. Ethnic diversity changes in North Macedonia (1994-2021);
Source: Created by the authors

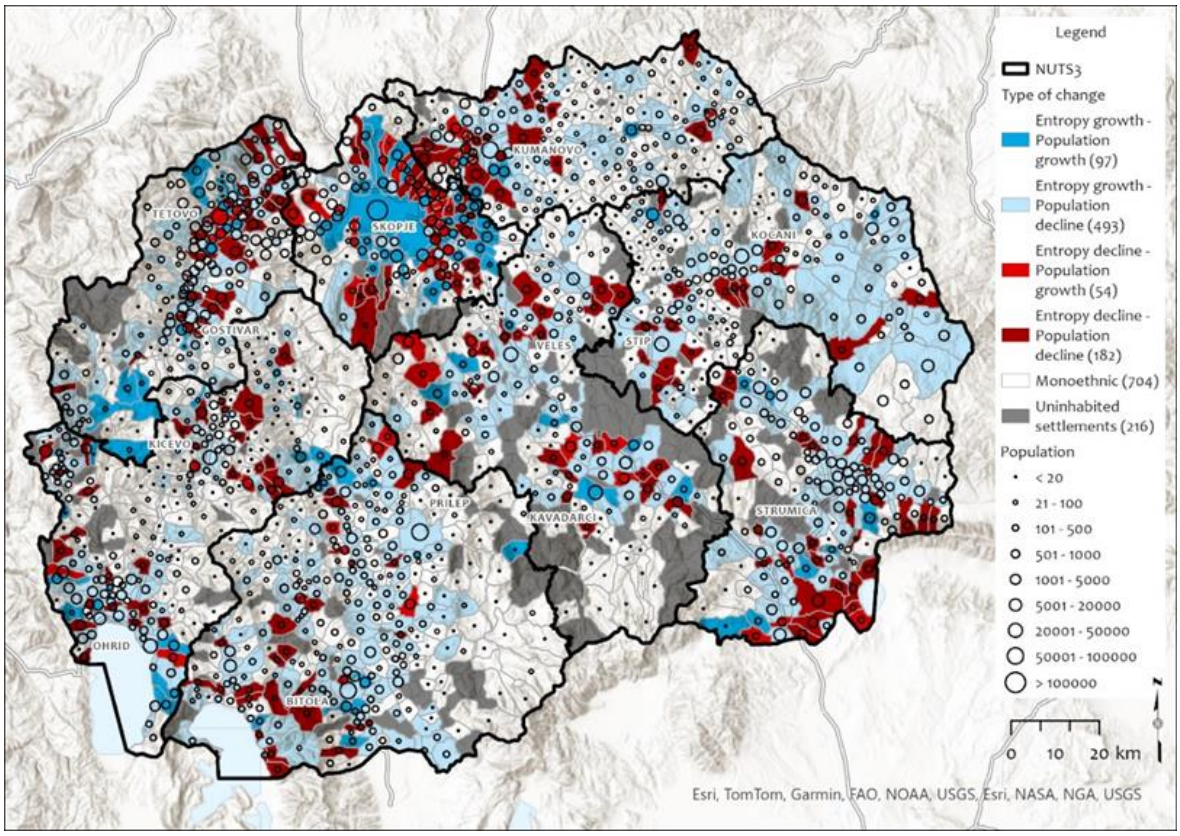

Figure 4. Ethnic diversity and population changes in North Macedonia (1994-2021)
Source: Created by the authors

CONCLUSION

This study departs from the typical research focus on ethnic diversity, which often centres on economically developed regions characterised by high levels of international immigration. Instead, our attention is directed towards North Macedonia, a developing multiethnic country marked by depopulation and emigration. Our analysis covers period from 1994 to 2021 and operates at a lower geographical scale – settlements.

The study findings reveal important regional disparities in ethnic diversity within North Macedonia. Much of the country's territory is dominated by settlements with low levels of diversity, nearly half of all inhabited settlements are monoethnic, primarily located in rural, higher altitude, and sparsely inhabited areas. While "pockets" of ethnic heterogeneity are evident around larger urban centres and some historically diverse, particularly border regions. In terms of diversity dynamics, our results indicate that demographic trends have been crucial in shaping ethnic diversity, particularly declining fertility rates and emigration. An important finding in particular is the relationship between ethnic diversity changes and uneven depopulation across different ethnic groups. The decline in the number of Macedonians, who constitute the majority population in most settlements, accompanied by the slower decline and stagnation of some other ethnicities, has led to an increase in ethnic diversity and a decline in ethnic segregation. Regional disparities in ethnic diversity further emphasise this relationship, with increases primarily observed in settlements with a majority Macedonian population, par-

ticularly in the Eastern and South-eastern regions. We can point out that migration is a contributing factor to ethnic diversity, particularly evident in the immigration of individuals from diverse ethnic backgrounds to urban centres like Skopje and its metropolitan region.

Overall, our analysis highlights the significant impact of demographic erosion, especially among the majority population, on ethnic diversity in North Macedonia. While some settlements have experienced population growth and increased ethnic diversity, a larger number have faced population decline and increased entropy, emphasising the complex interplay between demographic dynamics and ethnic diversity. These findings offer valuable insights into the socio-cultural and demographic landscape of the country, providing a foundation for understanding the various factors influencing changes in ethnic diversity and informing measures to promote social cohesion and integration. These findings have implications for understanding the socio-cultural and demographic landscape of the country and can serve as a basis for a better comprehension of the various factors influencing changes in ethnic diversity and help to develop appropriate measures to promote social cohesion and integration amidst evolving demographic landscapes.

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MAIN CHARACTERISTICS OF MACEDONIAN MOUNTAIN TOURISM

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ABSTRACT

The paper presents the main characteristics of Macedonian mountain tourism - the attractive factors (the main natural and anthropogenic motives), the receptive factors (accommodation and catering facilities) and the communicative factors (traffic network, cable cars, ski lifts). In parallel with the research, several anniversaries are being celebrated in the tude, a century since the beginning of mountaineering (1924-2024), nine decades since the first skiing and the construction of the first mountain lodges, eight decades since the construction of the first mountain hotels and ski centers. We pay considerable attention to the regional overview of mountain tourism, mountain settlements with over 1000 meters above sea level are listed. At the end, we present data on tourist movements (number of tourists and overnight stays) in mountain places for a period of several decades, as well as on other activities in the mountains.

Keywords: Macedonia, mountains, mountaineering, skiing, tourism

INTRODUCION

Staying in the mountains is often used for relaxation (spiritual and psychological needs), recreation (hiking, light hiking), sports activities (skiing, mountaineering, running, cycling), for education (observation, research), etc.

The first ascents of the high Macedonian mountains date back to the 19th century, and the first attempts at organized mountaineering, the formation of mountaineering societies, skiing and the construction of mountain lodges are registered in the third decade of the 20th century.

Macedonia, as a mountainous country, has extraordinary natural prerequisites and opportunities for the development of mountain tourism. Thus, recreation in the mountains, mountaineering, sports, education have become attractive forms of tourism that attract tens of thousands of tourists.

A significant and organized development of mountaineering and mountain tourism in Macedonia began in the eighties of the 20th century. The period of social transition left great shocks in Macedonian mountaineering and mountain tourism.

Owning mountains does not automatically mean gaining economic benefits. What is needed for the successful development of mountain tourism is actually an investment of money, people and efforts. Even today, Macedonian mountain tourism modestly invests in development. The promotion of mountain tourism requires extensive activity of competent institutions and significant state and private investments.

DATA AND METHODS

The main goal of the research is to present the beginnings of mountain tourism and the current conditions of mountain tourism in the line of development and perspectives of mountain tourism. The research is based on the application of quantitative and qualitative methods to determine the value and attractiveness of mountain tourism, especially for hiking, skiing, mountain biking, mountaineering and the like. Extensive literature, statistical data, personal mountaineering experience and conversation with authoritative persons in mountaineering were used.

RESULTS AND DISCUSSION

Beginnings and general characteristics of Macedonian mountaineering until the Second World War

According to morphometric characteristics R.N. Macedonia is a mountainous country. Most of the territory is occupied by the mountains with an area of 11,044 km^2 or 42.95%, followed by the hills with 9,769 km^2 or 37.99%, and the plains account for 4,900 km^2 or 19.06%. The total mountainous area is 23,713 km^2 or 81%, with an average altitude of 829 meters. (Andonovski, 1978; Markoski, 1995, 2004; Stojmilov, 2003)

Mountains are found in all parts of the country and according to their height they are divided into: high (over 2000 m), medium (from 1000 to 2000 m) and low (below 1000 m), and according to the appearance of old or massive and young or mountain ranges. Macedonia has 26 mountain ranges, of which 14 are higher than 2,000 m, and 5 mountains are higher than 2,500 m (Korab, Shar Planina, Baba, Jakupica and Nidze). On the high mountains there are over 300 peaks with a height of over 2000 meters. (Markoski, 1995, 2004; Stojmilov, 2003; Petrusevski, 2001; Dynchev, 2001; Marinoski, 2010; Dimitrov&Koteski, 2022)

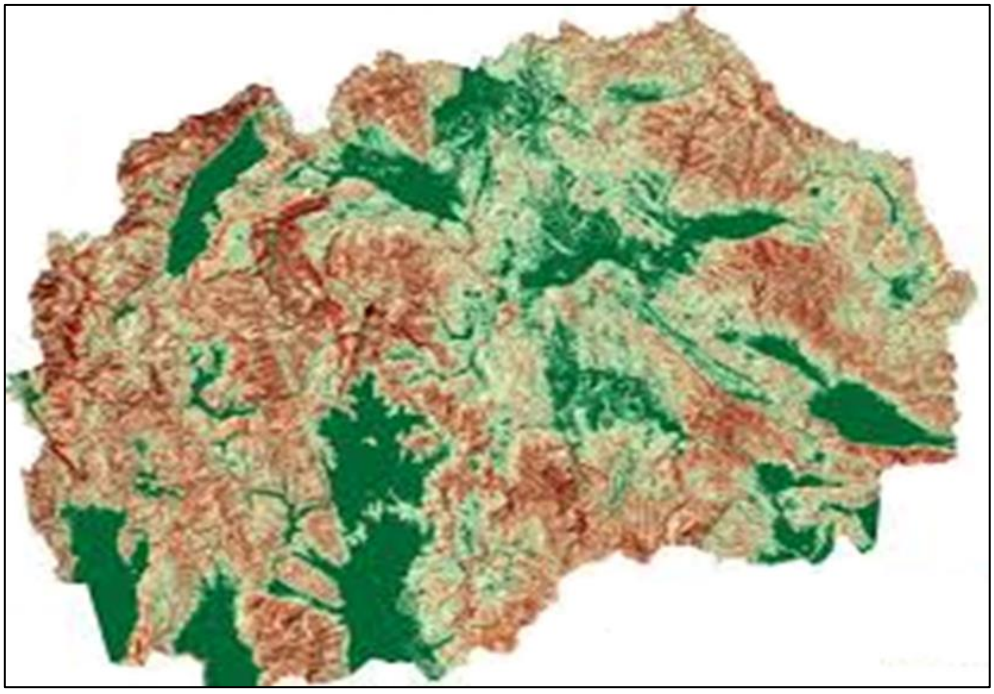

Figure 1. Map Morphometric appearance of the relief in R.N. Macedonia

The most attractive for tourists are the high mountains, with over 2000 m above sea level, which occupy a total area of 8194.2 km^2 (31.8%), of which the largest area is the Jakupica mountain with 1672.8 km^2, Osogovski mountains with 1167.2 km^2, Shar Mountain with 912.8 km^2, Kozhuf 893.0 km^2, Nidze 689.4 km^2, Bistra 572.8 km^2, Stogovo with Karaorman 522.0 km^2, Baba 436.2 km^2, Cheloitsa with Suva Gora 396.0 km^2, Galichica 387.2 km^2, Korab with Deshat 290.2 km^2 and Jablanica 254.6 km^2. The average height of the high mountains is 2185 meters. (Dimitrov, Popeska, Ristova, 2018; Dimitrov, 2021)

We find different data about the number of mountains, namely that there are 30, 40 and even 80 or more mountains. (Marinoski, 2010, Stojmilog, 1976, 2003, Markoski, 1996, 2004, Dimitrov, 2021). While, according to the type of relief, the mountain massifs in the Republic of Macedonia Markoski distinguishes four groups, namely: 5 mountains with over 2,500 meters or with distinctly high mountain relief, 9 mountains with high mountain relief from 2,000 to 2,500 meters, 10 mountains with medium mountain relief relief from 1,000 to 2,000 meters and 2 mountains with low mountain relief from 500 to 1,000 m.a.s.l. (Markoski, 1995, 2004)

The mountain topography was enough reason for various explorers of the mountain to climb the highest peaks. Thus, the first recorded and described ascents of the Macedonian mountains were in the 19th century, carried out by European scientists and researchers. The first ascent was on Shar Planina (Kobilitsa peak) and Pelister, and was carried out by the travel writer Ami Bue, in 1836. The second recorded ascent was on Mount Nidze, Pelister and Shar Planina, by the botanist August Griesebach, in 1839. The third foreigner was the travel writer Edmund Spencer who in 1850 climbed Pelister and visited the glacial Great Lake. The fourth travel writer who climbed Pelister in the fall of 1862 was Heinrich Barth. (Matkoski, 1992, 1992a, Popovska, 1999, Hristovski, 2008, 2010). All the mentioned travel writers left beautiful descriptions with valuable data.

It is worth highlighting the fact that in Bitola in the middle of the 19th century there were two large barracks (the White and the Red were stationed in several thousand soldiers). Also in the city there was a Military Gymnasium (later Military Academy) and a Lower Military School (Ruzdie). (Sterjkovski, 2020).

According to this, it is most likely that part of the training of the soldiers, students, cadets was also field walking, military marches in the mountain atar of the nearby Bitola villages (Bukovo, Lavci, Brusnik, Dihovo, Nizhepole, Trnovo, Magarevo, Rotino, etc.), by climbing nearby peaks to Bitola in about 2-4 hours of walking ("Oshin Kamen" 1865 masl - old name of the Orlovo Sedlo peak 1865 masl, then "Alanjik" - old name for the whole area from Neolica 1905 masl, "Dervish " 1532 masl - old name for the locality "Peshterka" 1532 masl etc.). (Dimitrov, 2022)

During the last decade of the 19th century and until the end of 1912, i.e. during the Turkish rule, in Skopje, Bitola and other cities in Macedonia there was a tradition in the spring months, on Sundays and certain holidays, citizens and students from city schools to organize field trips and visit nearby places. These excursions became a habit and they can be considered as the first steps of picnicking, which later turned into mountaineering.

After 1920, young mountain lovers from the cities of Skopje, Bitola, Prilep, Tetovo, Veles, Shtip and others began to visit and climb the surrounding and more distant Macedonian moun-

tains. Thus, a group of mountaineers climbed the high peaks of Korab, Shar Planina, Baba Planina, Yakupica, Nidze and other mountains. Visiting the mountains and climbing the peaks continued outside of Macedonia, so in 1928 the mountaineer Trajko Ribarov was the first Macedonian to climb Triglav (2863 m.). (Poljak, 1971; Ribarov, 1971)

The first Bitola scout association (of girl scouts and mountaineers) was founded in 1924. The first members were students from the Bitola High School. The scout association organized camps and hikes. (Sterjkovski, 2016)

From 1924 onwards, the first mountaineering societies were formed in the cities: Prilep (PD "Zlatovrv" 1924), Tetovo (PD "Ljuboten", 1925), Skopje (1930/31), Bitola (1930/31 and 1934), Kichevo (1935/36), Ohrid (1935/36), Krushevo (1936), Shtip (1936), Kumanovo (1936/37), Kočani (1936/37) and Veles (1936/37). In summary, in the period 1924-1939, 18 mountaineering societies/sections were formed in 11 cities. (Dimitrov, 2021)

For the beginning of organized activity, the first accommodation facilities in the mountains were two facilities: a children's resort in Pelister and a children's resort in Krushevo built in 1926, and in 1928 a military resort was built in Ponikva (Osogovski Mountains). The first mountain lodges were built in the period from 1930 to 1938, and a total of 5 lodges were built: "Ljuboten" 1930, "Kajmakchalan" 1931, "Popova Shapka", 1934, "Mavrovo", 1937 and "Kopanki", 1938 year. (Panov, 1968; Ribarov, 1971; Tockovski, 1970, 1973; Stojmilov, 1977; Stamenkov, 1987; Dynchev, 2001; Sterjovski, 2020; Dimitrov, 2021)

The mentioned eight accommodation facilities had a small capacity, the children's resorts with 200 beds each, the mountain lodges up to a maximum of 40 beds, so we estimate that in total there were about 800 beds in the mentioned locations.

Excursion tourism was represented on Pelister and during Sundays and holidays the mountain was visited by over 500 visitors. While stationary tourism was represented in Krushevo. Kruševo was the only confirmed mountain tourist place, in which, in addition to the children's resort, there were several inns and private houses that welcomed guests. The statistical data on the number of tourists in Krushevo speak for that. Namely, in the period 1937-1939, 1785 tourists visited the city and spent 28575 nights, so it had a high average stay of 16 days. (DS, Kraljevina Jugoslavija,1938-1941)

The first occurrences of vacationing in Malesheviata, in Berovo, especially for patients who need climate treatment, were recorded even before the Second World War. (Netkov, 1970)

In 1927, the first tourist company "South" was established in Skopje. In 1934, the Tourist Association "South" - Skopje had 656 members and 8 subsidiaries (Bitola, Tetovo, Kumanovo, Prilep, Ohrid, Veles, Shtip, Strumica). In 1935, this tourist association had 711 members and 13 subsidiaries (plus Kavadarci, Gevgelija, Kočani, Kichevo, Struga). The society also had a mountaineering section. (Ribarov, 1971; Poljak, 1971; Stojmilov, 1977)

In the period of the thirties, the beginnings of skiing activities were registered by the mountain societies in Tetovo (in 1925, the first steps with skis in the localities of Potok and Teće, and later this spread to the localities of Garjanska livada and Kale. In March 1926, skiing on Shar Planina, two mountaineers - skiers climbed to Ljuboten peak (Savoski, 2002) во Битола (1925 г. скијање низ улиците и во околината на Битола (Savoski, 2002), in 1934, PD "Pelister" acquired several pairs of skis, in 1937, the first ski section was established in the village of Gopeš.

Bo Bitola, skiing was registered in 1938 and in 1940 and 1941 two combined mountaineering-skiing competitions - (Sterjovski, 2016).

In Mavrovi Anovi in 1926 a military unit of the Skopje garrison was stationed, organized forms of skiing in Marvovo, and the Mavrovo villages of Leunovo and Nikiforovo, and in 1936 a ski section was formed in Mavrovo Anovi. In Skopje in 1932, the first skiing of Skopjes was registered in February on Ljuboten, and in March on Popova Shapka. In Gostivar, the first skiing was registered in 1934, in Krushevo already in 1931, skiing was done in the localities of Janasko, Gumna, Mala Korija up to the Three Roads. (Savoski, 2002)

The first attempt at alpinism was in 1934 on Nežilovski Steni in the area of Solunska Glava. (Poljak, 1971; Ribarov, 1971; Stojmilov, 1977). Mountaineers from Macedonia planned to climb the high Balkan mountains Rila, Olympus, Pirin and others, but their idea was not realized because of the war.

Development of Macedonian mountaineering and ski tourism

After the Second World War, the process of restarting and forming new mountaineering societies began. First, the Skopje Mountaineering Society was established in December 1944, which later bears the name PD "Skopje - Matica". In 1945, the Mountaineering Society "Pelister" was established in Bitola, which, in addition to mountaineering and skiing, was also involved in tourism. Upon their announcement, over 2,000 Bitol residents joined this society. (Stojmilov, 1977; Sterjovski, 2020). Then follows the establishment of new mountaineering societies in all cities in Macedonia.

In 1947, the first mountain hotel in the People's Republic of Macedonia was built on Popova Shapka. In Krushevo, next to the children's resort "Shuma Mina", the first mountain hotel "Ilinden" was built in 1949, and a little later the hotel "Panorama". (Tochkovski, 1970, 1973, Macedonia - touristic waters, 1956). The children's resort or sanatorium "Pelister" continues to operate on Pelister. (Tochkovsky, 1970)

From the mid-fifties and sixties, more workers' and children's resorts and hotels were built on Shar Planina (Popova Shapka), Bistra (Mavrovo) and Baba Planina - Pelister (Begova Cheshma). In 1957, the old mountain lodge was renovated and expanded on Mount Bistra. The first larger accommodation facility on Mount Bistra, in Mavrovi Anovi, is the "Skala" hotel, built in 1964. (Dimitrov, 2021)

Also, in the 1950s and 1960s, old mountain lodges were renovated on the mountains, and new larger ones were built (Vodno-Dare Jambaz 1952, Čeples 1952, Karadžica 1950, Begovo 1950, Ljuboten 1953, Jelak 1953, Visoka Chuka 1953, Gorno Vodno 1955, Derven 1955, mountain tower Titov vrv 1956, Matka 1956, Kopanki 1958, Kitka 1962, etc.). (Stamenkov, 1987)

From then on, mountaineering as a recreational and sports movement became popular, and mountaineering expeditions and marches are often organized to climb the Macedonian mountains, but also on mountains in other republics and provinces in SFR Yugoslavia. Macedonian climbers also climb the highest mountains in the Balkans (Rila, Pirin, Olympus), and later the Alps (the peak of Mont Blanc), other European mountains (Carpathians, Tatras, Pyrenees, Apennines, Caucasus), as well as the highest mountains in the world. (Atlas, Kilimanjaro, Andes, Elbrus, Pamir, Himalayas, etc.).

Today, there are more than 700 km of marked trails in the mountains of RN Macedonia, for hiking trails (400 km), skiing trails (60 km) and mountain biking trails (300 km). (Dimitrov, 2021)

During eighty years (1939-2020) the number of mountaineering societies and mountaineering lodges increased from 18 mountaineering societies to 76 societies or an increase of 4 times, and from 5 mountaineering lodges to 37 mountaineering lodges or an increase of 7 times. (Dimitrov, 2020a)

Viewed by altitude, the mountain lodges are distributed: 2 lodges up to 500 meters; 14 homes from 500 to 1000 meters; 13 homes from 1000 to 1500 meters; 5 homes from 1500 to 2000 m. and 3 mountain lodges at over 2000 m.a.s.l. (Mountaineering map, 2002, Federacija PSM).

In 1955, the first Macedonian mountaineering section was founded in Skopje, followed by mountaineering sections in Prilep and Kočani. Alpinists classically practice climbing the walls in the canyon of Trska nad Matka, but also on other rocks throughout Macedonia. (Poljak, 1971; Ribarov, 1971; Report, 1976)

The beginnings of organized mountain tourism were observed at the end of the 60s and the beginning of the 70s of the last century when several mountain hotels, workers', youth and children's resorts and seven ski centers were built (on Shar Planina - "Popova Shapka" 1947 .; on Bistra - "Mavrovo", 1959/1964; then Baba Planina - two ski centers - "Kopanki", 1975 and "Strezevo - Nizhnepole", 1984; on Busheva Planina - ski center "Krupevo - Stanich", 1988; followed by Osogovski Mountains - ski center "Ponikva", 1998 and lastly on Kozhuv Mountain - ski center "Kozhuf", 2006 year. (Dimitrov, 2020a, https://skimacedonia.mk/).

A total of 10 children's resorts operated on the mountains until the mid-nineties, namely: children's resort "Pelister", "Shula Mina", "Ponikva", "Bunec", "Golak", "Mihaljovo", "Plachkovica", "Suvi Laki". , "Malesevo" and "Pehchevo". (Panov, 1999; Mountaineering map, 2002; Dimitrov, 2021). Today, only two of these are active: "Bunec" and "Mihajlovo".

With the breakup of the former Yugoslavia and the military conflicts in the 1990s, mountain tourism lost its importance. A particular setback in mountain tourism was observed after the military conflict in 2001, when the Republic of Macedonia faced serious problems regarding the construction and maintenance of winter infrastructure (ski-lifts etc.).

In the function of mountain tourism are the tourist complexes and weekend settlements located on the following mountains: the tourist and weekend settlement "Mavrovo" is located on the Bistra mountain, the tourist and weekend settlement "Popova Shapka" is located on the Shar Mountain, the "Ponikva" is located on the Osogovo Mountains. , on Pelister are "Begova Cheshma" and "Nižopole", on Maleshevski Planini and by Berovsko Ezero are "Malesevo" and "Bela Voda", on Ogražden is the weekend settlement "Suvi Laki", on Golak mountain is the tourist settlement "Golak", on Jablanica weekend settlement "Gorna Gorica" and others.

These settlements have several hundred weekend houses, various accommodation and catering facilities (hotels, villas, apartments, motels, mountain lodges, restaurants, cafes, pizzerias, pastry shops, etc.), as well as villas and bungalows of workers' organizations (which today are mostly inactive). (Dimitrov, 2021).

In the context of mountain tourism, we can also include 188 mountain settlements with a height of over 1000 m above sea level. Unfortunately, most of these settlements face infrastructural and demographic problems and cannot contribute to the promotion of mountain tourism. (Dimitrov, 2009)

Table 1. Number of visitors and overnight stays in mountain places, 1953-2022

Year	Number of visitors - tourists			Number of nights		
	Mountainous places			Mountainous places		
	In total	Homemade	Foreign	In total	Homemade	Foreign
1953	8312	8262	50	41642	41523	119
1961	9357	9288	69	36445	36265	180
1971	22436	21989	447	71719	70658	1061
1981	55766	52780	2986	230676	224822	5854
1986	**94615**	**87258**	7357	**295046**	**282800**	12246
1987	84300	76606	7694	252535	237337	15198
1991	55767	46652	9155	183043	144961	38082
1994	58249	53586	4663	162428	152557	9871
2001	38830	36411	3419	106559	98481	8078
2002	41648	39139	2509	119369	114148	5221
2006	40089	32394	7695	110337	89200	21137
2008	43165	35665	7500	110012	94063	15949
2009	52484	40130	12354	120891	97275	23616
2010	**71457**	**58170**	13287	160336	131786	28550
2011	71309	58100	13209	161382	129937	31445
2012	68809	55076	13733	144293	110865	33428
2013	68745	52615	16130	144125	105301	38824
2014	64707	47975	16732	135518	95877	39641
2015	62335	44502	17833	136436	97831	38605
2016	56491	41630	14861	125185	95527	29658
2017	58752	40907	17845	125589	93616	31973
2018	65381	43362	22019	139912	99085	40827
2019	70907	46198	**24709**	147608	103579	**44029**
2020	52531	46058	6473	111268	100268	11000
2021	56650	43952	12698	120684	96361	24323
2022	61025	45328	15697	130560	100067	30493

Source: SZS: National Institute of Statistics. Tourism in the Republic of Macedonia, Statistical Review, Skopje, 1954, 1962, 1972, 1982, 1992, 1995, 2002, 2003, 2006-2010, 2011-2015, 2016-2018, 2019-2022 https://makstat.stat.gov.mk/PXWeb/pxweb/mk/MakStat/MakStat__TirizamUgostitel__Turizam__TuristiNokevanja/605_Turizam_RM_MestaGod_ml.px/table/tableViewLayout2/;
https://www.stat.gov.mk/publikacii/2023/SG2023-web.pdf (in Macedonian);

In the Macedonian mountains, in addition to active hiking and skiing, there are trails for cycling, paragliding, rock climbing, mountaineering, mountain running, speleology, etc. Various events are organized throughout the year ("Sharplan Cup" - international, FIS slalom, vele slalom, FIS Snowboard Cup; "Mavrovo Memorial" in Nordic running; "Pelisterski vele slalom", "Snow City" in Mavrovo and others). During the time when the events are held, the number of

visitors increases several times more than on the days when there is no event. On the mountains, more than a hundred hiking trails, about twenty bicycle trails, then 5 mountain transversals, 3 of which are of international importance, 5-6 locations for mountaineering, a dozen locations for paragliding, speleology and rock climbing. (Dimitrov, 2021)

The numerical movement of tourists and overnight stays in mountain places for the period from 1953 to 2022 is shown in table 1 and graph 1 and 2. The data shows a continuous increase in visits and overnight stays. The maximum values of visits and overnight stays were in 1986. From the table, we notice a certain decrease in 1991, the period when SFR Yugoslavia is disintegrating, then in 2001 - the military conflict in Macedonia, in 2015, social economic crisis and in 2020 due to the COVID-19 pandemic.Tables 1.

Throughout the entire period, domestic tourists dominate. Foreign tourists mostly visit the Macedonian mountains during the summer season. These are mostly tourists from neighboring countries, but also tourists from other European countries and beyond.

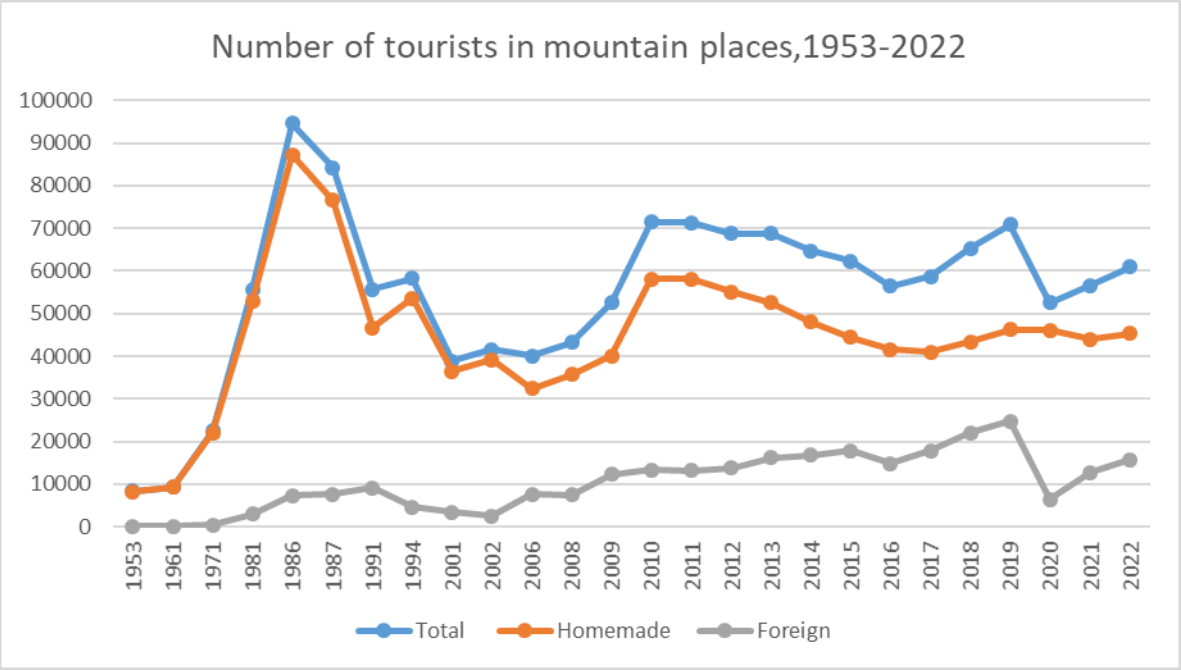

Figure 1. Number movement of tourists in mountain places, 1953-2022

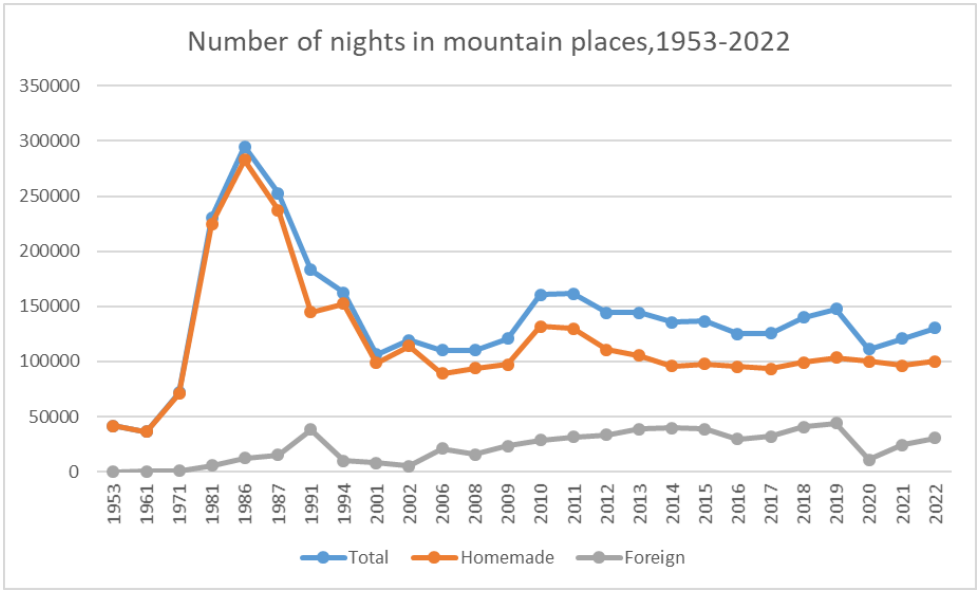

Figure 2. Numerical movement of tourist nights in mountain places, 1953-2022

Mountain tourism by planning regions

Since 2009, the area of R. Macedonia is divided into eight statistical planning regions. Mountains are found in all planning regions, so the regions have natural prerequisites for the development of mountain tourism. In this section, we will present two tables with data on the mountain tourism potential for each region. (Table 2 and 3).

Table 2. Several parameters for mountain tourism by planning regions

Planning region	Several parameters for mountain tourism										
	Important mountainstains *	Mountaineering societies *	Mountain lodges *	Mountaineering tourist zonee	Mountain tourist sites	Ski centers	Accommodation facilities и *	*From that*		Rooms and apartments	Bed
								Hotels, hostels, motels	*Resorts. villas etca*		
Vardar	9	10	6	1	4	0	12	*2*	*10*	72	225
Eastern	11	10	5	7	15	1	72	*10*	*62*	366	1098
Southwest	14	5	3	2	12	0	41	*8*	*33*	192	454
Southeast	12	8	4	3	10	1	19	*4*	*15*	88	243
Pelagonia	15	13	5	5	27	3	70	*9*	*61*	421	1204
Polog	9	6	6	5	17	2	167	*23*	*144*	980	2977
Northeast	5	5	3	2	8	0	15	*3*	*12*	70	172
Skopje	8	30	5	3	8	0	27	*2*	*25*	217	616
Total	**83**	**87**	**37**	**28**	**101**	**7**	**423**	***61***	***362***	**2406**	**6989**

*More than thirty important mountains border one or more regions (example: Osogovski Mountains, Plackovica, Ograzhden, Krcin, Deshat, Bistra, Galichitsa, Dautitsa, Karadzhitsa, Goleshnica, Babuna, Ilinska Mountain, Plakenska Mountain, Busheva Mountain, Baba Sach, Cheloitsa, Suva Gora, Klepa, Kozjak, Konechka Planina, Gradeshka Planina, Kozhuf, Skopska Crna Gora, Zeden and others.). Most of the mountaineering societies and mountaineering lodges are not active. *Data for accommodation facilities (facilities, rooms, beds, tourists, nights, etc.) are calculated using data from several websites (https://macedonian-hotels.mk/mk; http://www.odisea.mk/index.php/macedonia-accommodation-excursions/otelsko-smestuvanje-makedonija; https://macedonian-hotels.mk/mk;https://kajak.mk/smestuvanja/site/; https://www.stat.gov.mk/OblastOpsto.aspx?id=25 ; https://www.booking.com/).

From the data in Table 2, we note the following characteristics: planning regions with the most mountains are Pelagonia with 15 and southwestern with 14 mountains, the most mountaineering societies are in the Skopje region 30, in the Pelagonia region 13, the most mountain lodges are in the Vardar and Polog regions 6, the eastern region has the most mountain tourist zones 7, the Pelagonia region has the most mountain tourist sites 27, the Pelagonia region has the most ski centers 3, the Polog region has the most accommodation facilities 167, of which 23 hotels and 144 villas and resorts, 980 rooms and 2977 beds. According to the data in the table for the regions, it is noted that the Polog planning region dominates mountain tourism, followed by the Pelagonian and Eastern planning regions.

In general, according to the mentioned parameters for mountain tourism, the Republic of Macedonia has a total of 83 important mountains, 87 mountaineering societies, 37 mountain lodges, 28 mountain tourist zones, 101 mountain tourist sites, 7 ski centers, 423 accommodation facilities, of which 61 are mountain hotels. 662 villas and resorts, 2406 rooms with 6989 beds. All the listed data are sufficient prerequisites and arguments for serious planning of mountain tourism through the preparation and application of a long-term strategy for the development of mountain tourism.

Table 3. Tourist data for planning regions and mountain places

Planning region Percent (%)	Number of tourists, overnight stays, rooms and beds in planning regions and total				Number of tourists, overnight stays, rooms and beds in mountain places by planning regions and participation in percentages			
	Tourists	Overnight	Room	Bed.	Tourists*	Overnight	Rooms *	Bed *
Polog	41994	84138	1240	3769	**28385**	**57084**	**980**	**2977**
	100	*100*	*100*	*100*	***67,59***	***67,84***	***79,03***	***78,98***
Pelagonia	72833	183520	3666	10846	13546	34416	421	1204
	100	*100*	*100*	*100*	*18,60*	*18,75*	*11,48*	*11,10*
Eastern	32077	62878	734	2088	10103	19763	366	1098
	100	*100*	*100*	*100*	*31,49*	*31,43*	*49,86*	*52,58*
Southwest	445846	1618312	16943	43312	7917	15742	192	454
	100	*100*	*100*	*100*	*1,77*	*0,91*	*1,13*	*1,05*
Skopje	389182	688324	3839	8049	4783	10631	217	616
	100	*100*	*100*	*100*	*1,23*	*1,54*	*5,65*	*7,65*

Southeast	167451	562422	2467	6367	3348	6690	88	243
	100	*100*	*100*	*100*	*1,99*	*1,19*	*3,56*	*3,81*
Vardar	25136	48590	663	1748	1803	1972	72	225
	100	*100*	*100*	*100*	*7,17*	*4,06*	*10,86*	*12,87*
Northeast	10444	14214	381	763	1022	1310	70	172
	100	*100*	*100*	*100*	*9,78*	*9,21*	*18,37*	*22,54*
Total	**1184963**	**3262398**	**29933**	**76942**	**70907**	**147608**	**2406**	**6989**
%	*100*	*100*	*100*	*100*	*5,98*	*4,52*	*8,04*	*9,08*

*Data for accommodation facilities (facilities, rooms, beds) and tourist traffic (tourists, overnight stays) are calculated using data from several websites (https://macedonian-hotels.mk/mk; http://www.odisea.mk/index.php/macedonia-accommodation-excursions/otelsko-smestuvanje-makedonija; https://macedonian-hotels.mk/mk; https://kajak.mk/smestuvanja/site/; https://www.stat.gov.mk/OblastOpsto.aspx?id=25 ; https://www.booking.com/) ; SSO – METASTAT Database, Meta data and calculations by the author.

From the data in Table 3., we note the following characteristics: planning regions with the most tourists in mountainous areas are the Polog region with 28,385 tourists and 57,084 overnight stays, followed by the Pelagonian region with 13,546 tourists and 34,416 overnight stays, the Eastern region with 10,103 tourists and 19,763 overnight stays, the southwestern region with 7,917 tourists and 15,742 overnight stays, etc. Also, from the data presented in Table 2, the dominant role of the Polog planning and mountain region in the development of mountain tourism in the country is confirmed. Namely, the number of mountain tourists, overnight stays, rooms and beds in the total number for the planning region is over 67 to 79%. In second place in absolute numbers is the Pelagonian region, and in percentage share is the eastern region with over 31 to 52%, etc.

CONCLUSION

The potential of Macedonian mountain tourism is great, because the mountains abound with natural conditions for the development of mountaineering, sports, educational, recreational and other forms of alternative tourism. However, despite decades of tradition for mountain tourism, it faces a number of problems of insufficient accommodation facilities, inadequate infrastructure, irregular maintenance of the road network, lack of tourism staff, etc.

Our research shows that hiking, sports and recreation are also necessary for the successful prevention of typical diseases of modern civilization, visible. So, according to medical practice, we can add that the Macedonian mountains are a good "air-sun bath of the best medicines: sun, water, air", which are in abundance and offered to every visitor. The Macedonian mountains, without any exaggeration, have potentials for the development of health tourism as well.

From the above we can conclude that Macedonian mountain tourism has perspectives and future challenges in all planning regions. However, in order to realize this, mountain tourism needs to be modernized in the management of natural resources, their regular monitoring, as well as monitoring of activities that will solve any negative impact. One of the things that should happen sooner is the preparation and implementation of the Strategy for the Development of Mountain Tourism in the R.N. Macedonia.

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POPULATION AGEING IN CROATIA: REGIONAL DIFFERENCES AND CHALLENGES

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ABSTRACT

The contemporary demographic picture of Croatia is characterized by depopulation and population ageing. According to the results of the latest population census in 2021, Croatia, with a share of the population aged 65 and over at 22.5% and a median age of 45.4, ranks among the world's oldest countries. This paper examines regional differences in population ageing within Croatia and the availability of formal care, i.e., elderly care homes. The analysis data shows that differences in the possibilities of institutional care provision are continuously increasing in the organization of formal care forms, mainly in terms of the level of economic development. Counties more exposed to strong emigration, sparsely populated, with a higher proportion of population primarily engaged in agriculture, are the counties with a higher number of older people, higher proportion of single-person households, lower GDP, higher poverty risk rate, and less organized forms of institutional accommodation.

Keywords: population ageing, formal care, elderly care homes, counties, Croatia

INTRODUCION

In European Union countries, care policies are increasingly oriented towards facilitating the ability of older persons to age in place, emphasizing the importance of enabling them to stay in their own homes for as long as possible. This approach is complemented by the establishment of diverse non-institutional forms of assistance and home care services. Concurrently, care policies for the elderly in Croatia only partially align with European trends. This discrepancy arises from several factors, including underdeveloped local governance structures for care systems, inadequate networks of institutional care facilities, and ambiguous financing systems (Žganec et al., 2007), compounded by significant economic disparities.

Croatia, with a demographic landscape characterized by decades-long depopulation accompanied by rapid ageing, presents a challenge for planning formal care for the elderly and devising sustainable public policies. This challenge is particularly significant due to the rising number of individuals aged 80 and above. Within this demographic, there is an increasing proportion of people experiencing compromised physical and/or mental health, which impedes independent living for many. This growing segment of the population requires various forms

of long-term care (LTC), which can only be provided by well-organized institutional care facilities.

Care for the elderly in Croatia, like in most European countries, relies on informal caregivers (Klempić Bogadi and Podgorelec, 2024). The socio-cultural and economic conditions of elderly Croatian citizens vary depending on their geographical location – whether they live in urban or rural environments, large or small cities, economically developed or less developed areas, regions experiencing migration influxes or declines, or depopulating regions. What is common across all areas, regardless of their level of development, is mutual assistance and caregiving primarily within the family or household. Whether it involves material (not just financial), emotional, and/or instrumental assistance, help or care is most often provided by spouses, children (more often daughters) (Štambuk et al., 2019), and other family members, friends, and neighbours (Podgorelec, 2008; Podgorelec and Klempić Bogadi, 2013). However, changes that Croatian society has undergone in recent decades, particularly in terms of reducing household sizes and family structures, gender equality in employment, and significant migration of younger populations (from rural to urban areas, but increasingly abroad in the past decade), necessitate well-organized formal care for the elderly (Klempić Bogadi and Podgorelec, 2024). For example, the inability to receive support and/or care from children was highlighted by nearly one-fourth of respondents (24.5%) in a study conducted on a large, albeit self-selected, sample of 3001 users of social care centres across all Croatian counties (Penava Šimac et al., 2022). In this paper, we will use standard ageing indicators to demonstrate the spatial aspect of population ageing in Croatia, as well as the availability of formal care, i.e., elderly care homes. We analyse data from population censuses 2001, 2011, and 2021, as well as data from the Ministry of Labor, Pension System, Family, and Social Policy on elderly care homes. In this way, we aim to provide a spatial demographic sketch of the level of population ageing and unequal availability of institutional care forms across various parts of Croatia.

Regional Differences in Population Ageing in Croatia

Demographic ageing has emerged because of declining fertility rates and extended life expectancy. In Croatia, this process has been further accelerated due to several decades of emigration. Emigration to European countries began as early as the 1960s and has continued to the present day, varying only in intensity over the decades. The Homeland War in the 1990s, along with other unfavourable demographic effects, hastened the ageing process (Nejašmić and Toskić, 2013). Croatia's accession to the EU in 2013 intensified emigration, resulting in an acceleration of depopulation and ageing. In the intercensal period from 2011 to 2021, Croatia experienced a decrease of 413,056 inhabitants, representing a decline of 9.6%. During the same period, the number of elderly residents increased by 110,606, or 14.6%. According to the results of the latest population census in 2021, Croatia, with a share of the population aged 65 and over at 22.5% and a median age of 45.4, ranks among the world's oldest countries.

Although demographic ageing is a characteristic of the entire Croatia, its intensity varies among different regions. The counties with the most unfavourable values of ageing indicators are as follows: Šibenik-Knin (share of the elderly in the total population 27.4; ageing index 215.0;

average age 47.0; old-age dependency ratio 45.8), Lika-Senj (share of the elderly in the total population 26.3; ageing index 209.6; average age 46.8; old-age dependency ratio 42.9), and Primorje-Gorski kotar (share of the elderly in the total population 25.8; ageing index 207.3; average age 46.7; old-age dependency ratio 41.8) (Table 1).

Table 1. Indicators of population ageing by counties in Croatia in 2021

County	Population	People aged						Ageing index	Old-age dependency ratio	Average age
		0-14 years		15-64 years		65 and over years				
		no.	%	no.	%	no.	%			
Croatia	**3,871,833**	**552,416**	**14.3**	**2.450.178**	**63.3**	**869,239**	**22.5**	**157.4**	**35.5**	**44.3**
Zagreb	299,985	44,605	14.9	191.459	63.8	63,921	21.3	143.3	33.4	43.5
Krapina-Zagorje	120,702	16,595	13.7	79.031	65.5	25,076	20.8	151.1	31.7	44.0
Sisak-Moslavina	139,603	18,238	13.1	86.864	62.2	34,501	24.7	189.2	39.7	45.9
Karlovac	112,195	14,452	12.9	70.276	62.6	27,467	24.5	190.1	39.1	46.2
Varaždin	159,487	22,153	13.9	104.183	65.3	33,151	20.8	149.6	31.8	43.9
Koprivnica-Križevci	101,221	14,618	14.4	64.326	63.6	22,277	22.0	152.4	34.6	44.2
Bjelovar-Bilogora	101,879	14,653	14.4	63.552	62.4	23,674	23.2	161.6	37.3	44.7
Primorje-Gorski kotar	265,419	33,058	12.5	163.822	61.7	68,539	25.8	207.3	41.8	46.7
Lika-Senj	42,748	5,356	12.5	26.168	61.2	11,224	26.3	209.6	42.9	46.8
Virovitica-Podravina	70,368	9,925	14.1	44.977	63.9	15,466	22.0	155.8	34.4	44.5
Požega-Slavonia	64,084	9,152	14.3	40.288	62.9	14,644	22.9	160.0	36.3	44.5
Slavonski Brod-Posavina	130,267	18,574	14.3	82.233	63.1	29,460	22.6	158.6	35.8	44.4
Zadar	159,766	23,264	14.6	98.211	61.5	38,291	24.0	164.6	39.0	44.6
Osijek-Baranja	258,026	35,416	13.7	165.876	64.3	56,734	22.0	160.2	34.2	44.5
Šibenik-Knin	96,381	12,279	12.7	57.702	59.9	26,400	27.4	215.0	45.8	47.0
Vukovar-Sirmium	143,113	20,166	14.1	90.255	63.1	32,692	22.8	162.1	36.2	44.6
Split-Dalmatia	423,407	62,619	14.8	268.678	63.5	92,110	21.8	147.1	34.3	43.6
Istria	195,237	26,035	13.3	122.043	62.5	47,159	24.2	181.1	38.6	45.8
Dubrovnik-Neretva	115,564	17,728	15.3	71.813	62.1	26,023	22.5	146.8	36.2	43.8
Međimurje	105,250	16,886	16.0	66.707	63.4	21,657	20.6	128.3	32.5	42.9
City of Zagreb	767,131	116,644	15.2	491.714	64.1	158,773	20.7	136.1	32.3	43.0

Source: author's calculation based on the data from the Census 2021

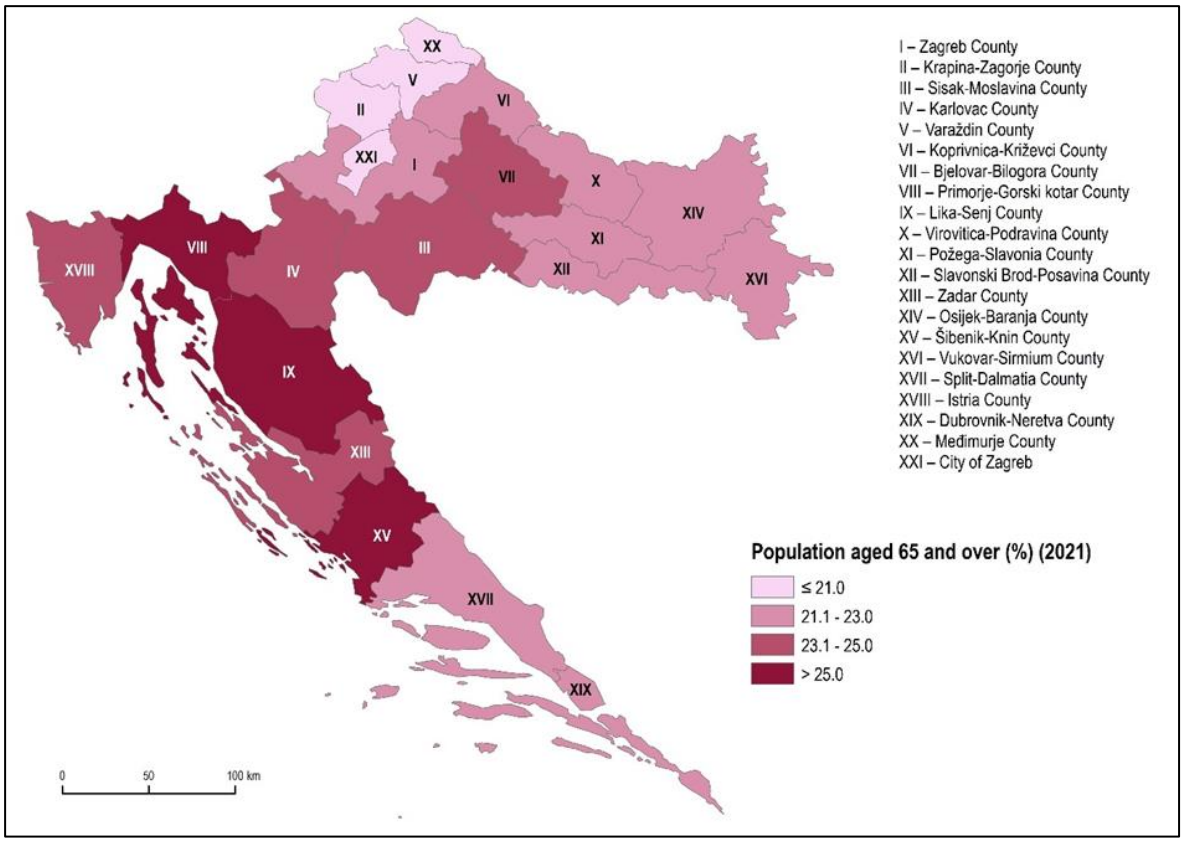

Figure 1. The share of the population aged 65 or older in the total population by counties in Croatia in 2021

On the other hand, the smallest share of the elderly, the most favourable ageing index, and the lowest average age are found in Međimurje County and the City of Zagreb (Figure 1).

In comparison to the growth of the population aged 65 or over, the increase of the population aged 80 and above is even faster. In 2021, Croatia was home to 214,666 persons aged 80 or older, accounting for 5.5% of the total population. Twenty years earlier, their number was half as much (99,507), constituting only 2.2% of the population (CBS, 2002). The proportion of people aged 80 years or older varies across regions. The lowest percentages are found in Zagreb County and Međimurje County at 4.7%, and Varaždin County at 4.9% (CBS, 2022a). Additionally, six counties have proportions below the national average, while two match the Croatian average. Conversely, ten counties exceed the national average. Particularly notable are Lika-Senj County at 8% and Šibenik-Knin County at 7.8%, highlighting an exceptionally unfavourable age structure in these areas (Figure 2). The increase in the number of individuals aged 80 and over indicates a rising need for formal care, long-term care, and placement in elderly care homes. In Croatia, significant regional disparities are evident in the development and quality of healthcare networks and social services (Klempić Bogadi and Podgorelec, 2024).

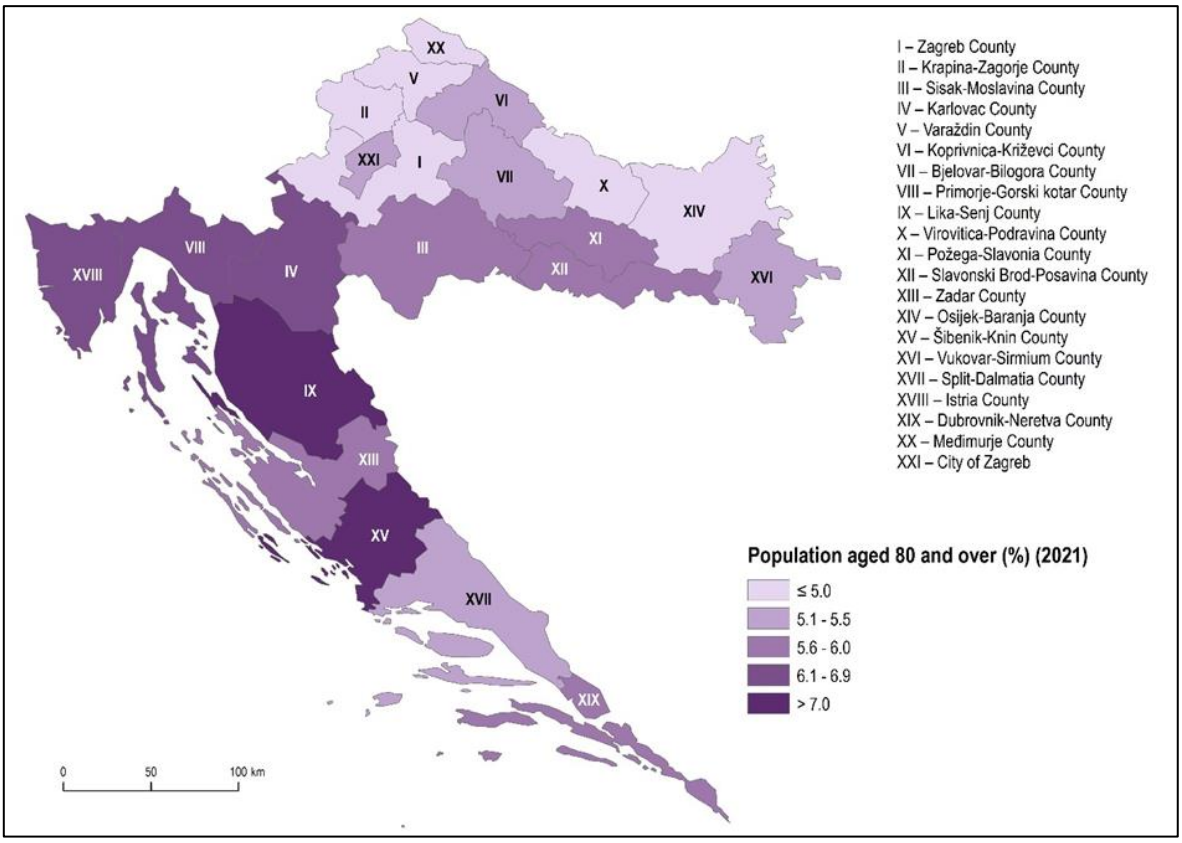

Figure 2. The share of the population aged 80 or older in the total population by counties in Croatia in 2021

Households of Older Persons Living Alone

Another demographic trend characterizing European countries is the continuous increase in single-person households. In 2021, older people lived in 50.5% of these households in Croatia (CBS, 2023). This is very important not only in demographic terms but also for various public systems, primarily healthcare and social care. The living arrangements of older people play a crucial role in shaping "their economic well-being, as well as their physical, psychosocial health, and overall life satisfaction" (UN, 2020, p.1). Living in a single-person household is often results in an increase in feelings of loneliness and actual social isolation. Additionally, it increases the need for services to enable older individuals to continue living in their own homes (Klempić Bogadi and Podgorelec, 2024). In 2021, the elderly lived in 201,673 single-person households, of which 144,369 were female single-person households, and 57,304 were male (CBS, 2023). Women tend to live longer than men, and this is reflected in the gender gap at older ages. In 2021, among individuals aged 65 and over, 58.4% were women. With advanced age, their proportion increases, so in the age group of 80 and over, they make up 66.4% of the population (CBS, 2022a).

In Croatia, older women were nearly twice as likely as their male counterparts to live alone, with share of 28.4% for women and 15.9% for men. The largest gender differences are observed in four Slavonian counties: Virovitica-Podravina (16.9 percentage points), Vukovar-Sirnium (16.6), Osijek-Baranja (16.4), and Požega-Slavonia (16.2) (Figure 3). Conversely, the smallest gender gap was observed in Krapina-Zagorje (6 percentage points), Varaždin (8.5) and Zagreb (8.7).

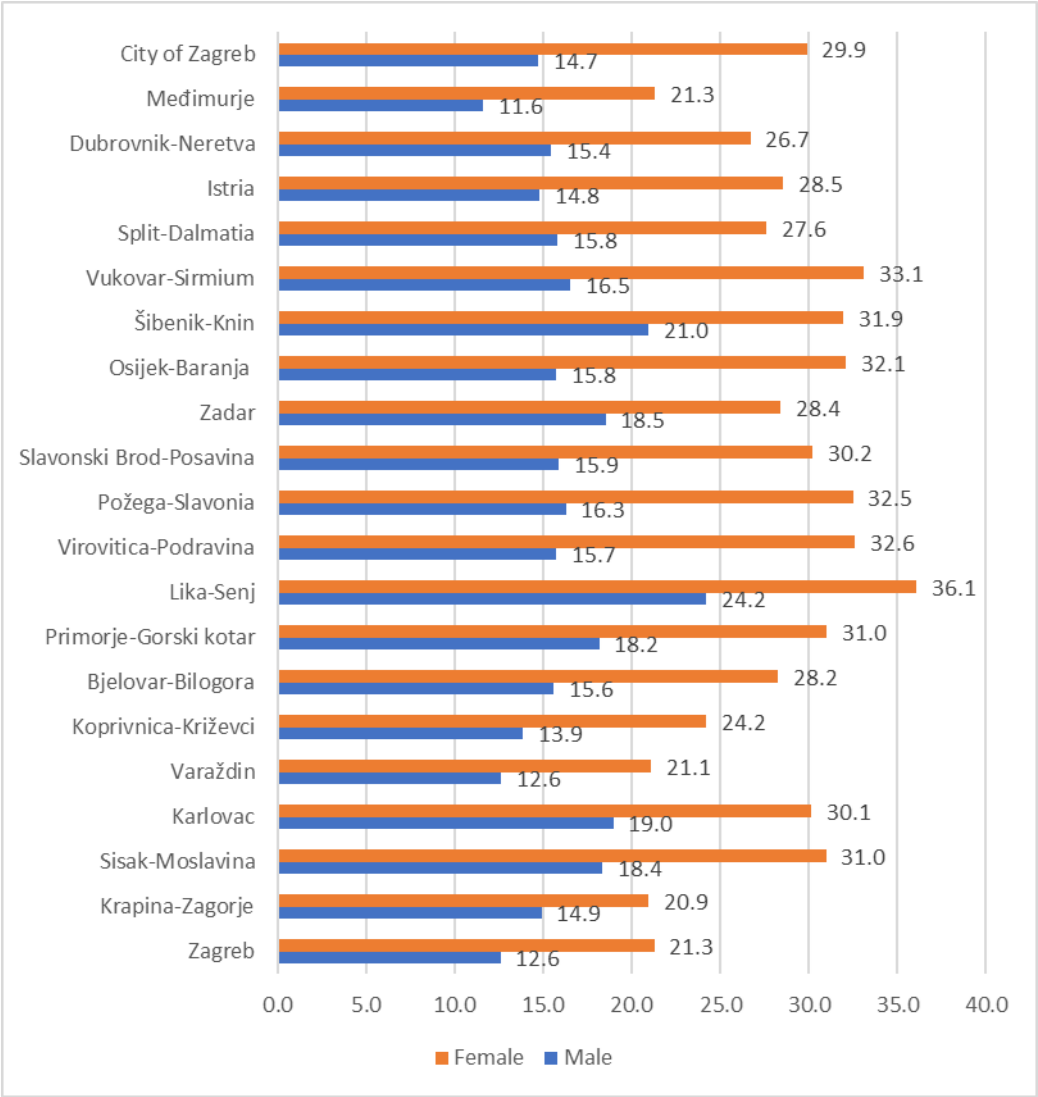

Figure 3. Percentages of men and women aged 65 years or over who live alone by counties in Croatia in 2021

Living alone for older persons is more acceptable and less stressful if it's their own choice and if, besides family, they have more or less regular contact with friends and/or neighbours.

In Croatia, single-person households of individuals aged 65 and older are at an extremely high risk of poverty. In 2023, at-risk-of-poverty rate of these households was 59.9% (CBS, 2024). At the same time, at-risk-of-poverty rate is 19.3%, but in the age group of 65 or older, it is almost double and amounts to 34.8%, which reflects the very unfavourable financial circumstances of a large number of older people (CBS, 2024). Tracking this indicator for the age group 65+ since 2018, when it was at 28.1%, reveals a consistent upward trend. During the same period, there was also a significant increase at-risk-of-poverty rate for single-person households aged 65+. It was 48.1% in 2018 (CBS, 2022b). In Croatia, there is a significantly larger number of women aged 65 and over who live alone, and women in general are at a higher risk of poverty compared to men.

The research on the geographical distribution of poverty in Croatia conducted by the CBS and the World Bank showed significant regional disparities (World Bank, 2016). The lowest estimates of the poverty risk rate were in the City of Zagreb (8.9%), Primorje-Gorski Kotar County (11.9%), and Istria County (11.9%). These are also the counties with the highest GDP per capita levels in Croatia. Counties with the highest risk of poverty were Brod-Posavina (35.9%) and Virovitica-Podravina (33.4%), which are also at the bottom of the GDP per capita ranking. The unfavourable economic position of certain counties is reflected in the organization of various public systems, including the one for formal care of the elderly. What makes the situation even more unfavourable is that economically weaker counties are areas of greater emigration, which also results in a reduction of potential informal caregiver. Growing regional economic inequalities and the existing partially decentralized organization of the social care system for the elderly lead to an increase in social inequalities among older population (Babić, 2017, p.25).

Elderly care homes

Older Croatian citizens are provided with formal institutional care by 3 state-owned homes, 45 county-owned homes, and 119 non-state or private homes (MROSP, 2023). The average proportion of older adults residing in elderly care homes in OECD countries is 4% (OECD 2021). According to the latest population census in Croatia (2021), 24,488 individuals aged 65 and above were living in institutional care, accounting for 2.8%. Data as of December 31, 2022 (MRSOP, 2023) shows that there were 18,936 residents in the three types of elderly care homes. Additionally, around 3% of older Croatian citizens are in institutional care, including those residing in smaller facilities such as family homes and through foster care arrangements.

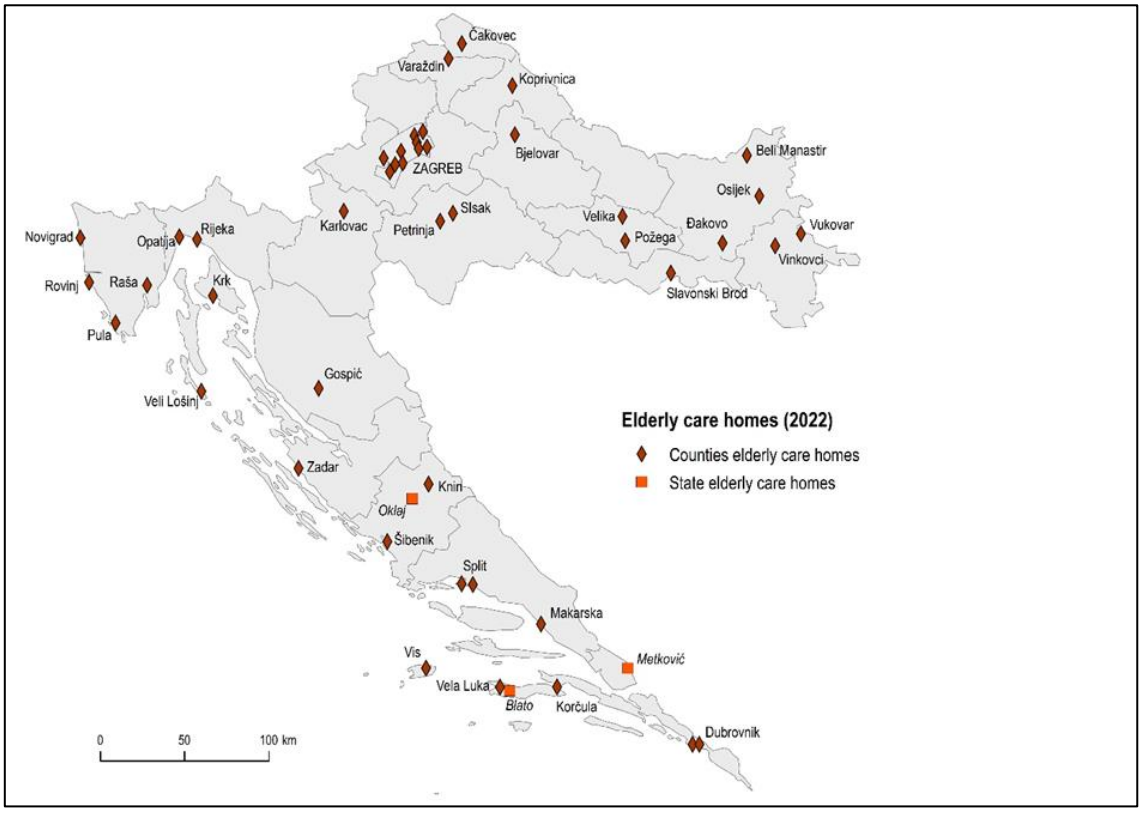

Figure 4. The spatial distribution of state and counties elderly care homes in Croatia in 2023

Only 169 elderly residents live in the three state-owned homes (MROSP, 2023). One is in Šibenik-Knin County, and two are in Dubrovnik-Neretva County. The largest number of older people, 10,525 of them, live in 45 non-state decentralized homes whose founder is a unit of regional self-government, i.e., counties (county care homes) – totalling 56% (MROSP, 2023). These homes are co-financed by the counties, making the accommodation prices considerably more affordable compared to private homes, and their capacities are consistently filled. Institutional care for the elderly was decentralized to regional self-government units (counties) in 2001, and since then, there have been no new public elderly care homes opened in county ownership (Babić, 2017). Since then, the number of older people has significantly increased, as well as the demand for institutional accommodation. Due to long waiting lists in county-owned homes, many of them are forced to go to private facilities, which are considerably more expensive. Furthermore, if a person wants to move to a elderly care home and continue living as close as possible to their home, often the only option is to go to a private facility.

In private homes with a capacity for 7,858 individuals, there were 7,213 residents by the end of 2022 (MROSP, 2023). Given that all private homes were established, and most were built in the 2000s, there is a significant difference in the quality and equipment of residential spaces compared to county care homes. Unlike them, county care homes were mostly built during socialism and require significant renovation. The advantage of county care homes over most private ones is that private facilities often cut costs on staffing (nurses and caregivers), resulting in inadequate levels of care despite higher accommodation prices (Klempić Bogadi and Podgorelec, 2024).

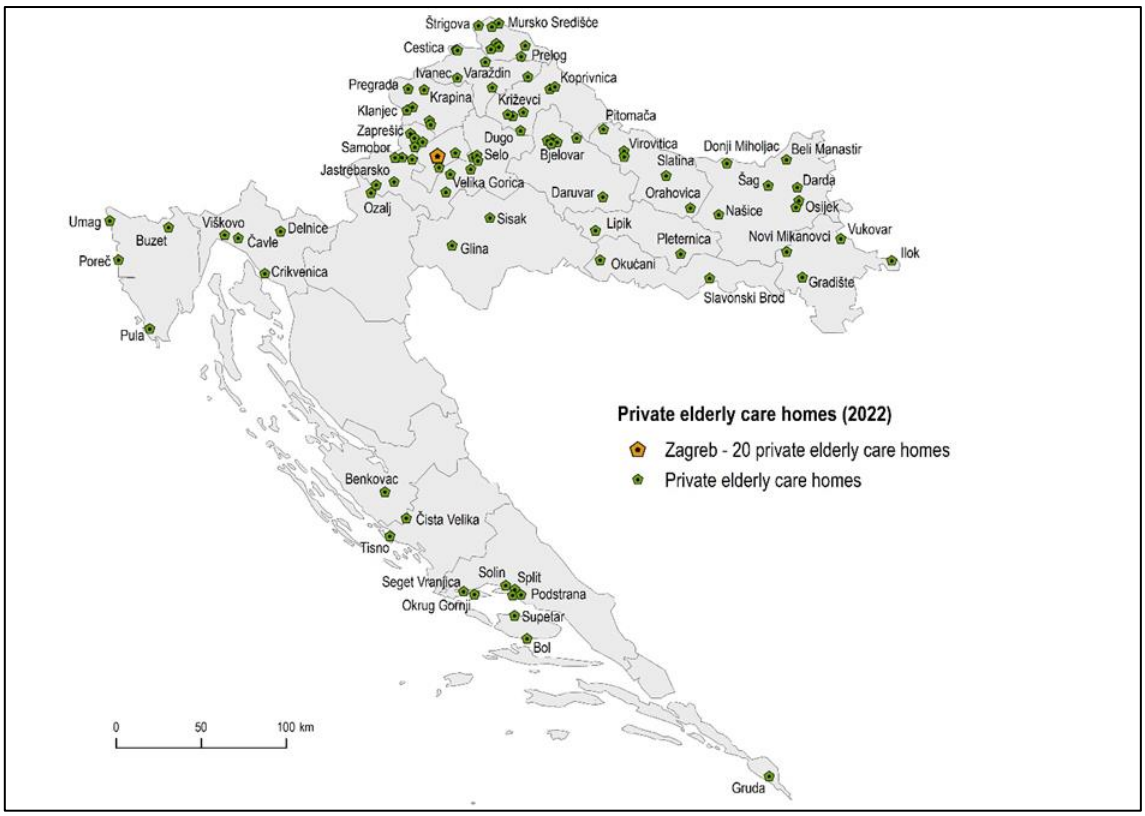

Figure 5. The spatial distribution of private elderly care homes in Croatia in 2023

The spatial distribution of elderly care homes indicates a significant concentration in the City of Zagreb – 10 out of a total of 45 county care homes and 24 private homes. However, the City of Zagreb is also home to the largest number of inhabitants aged 65 and above (158,773 or 18.2%) (CBS, 2022a). The proportion of older adults residing in elderly care homes in the City of Zagreb is slightly above the Croatian average, standing at 3.3% (CBS, 2023).

Three counties have a proportion of people aged 65+ residing in institutions above the European average. These are Međimurje County with 4.8% residing in one county care home and 10 private homes, Bjelovar-Bilogora County with 4.7% residing in 1 county care home and 6 private homes, and Koprivnica-Križevci County with 4.4% residing in 1 county care home and 6 private homes. In these counties, formal care accommodation in elderly care homes for older adults relies almost entirely on private capacities.

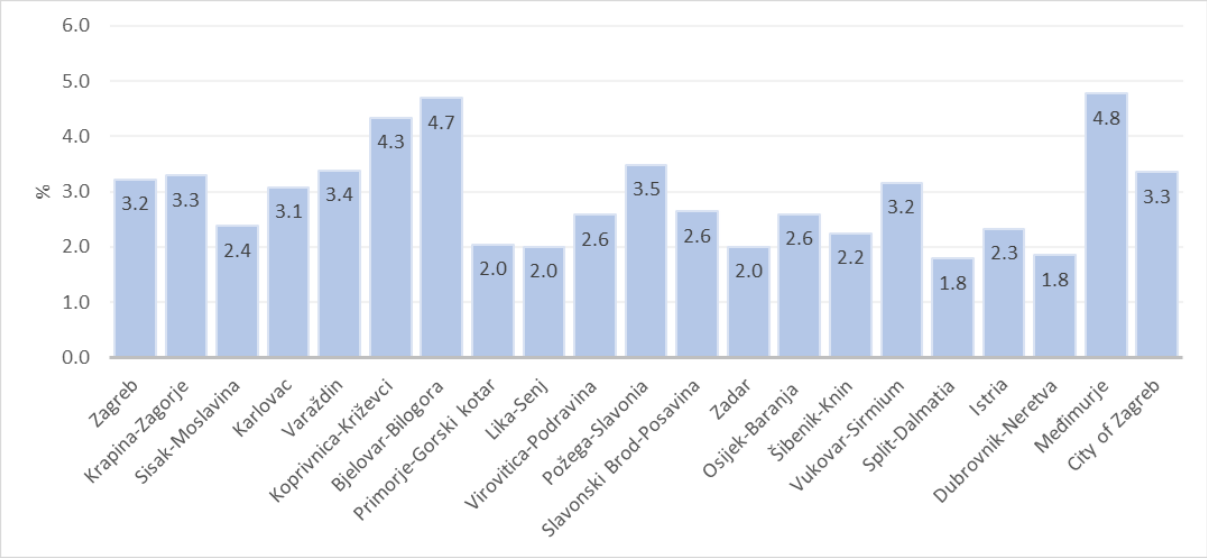

Figure 6. The share of persons aged 65 or older in the total population aged 65 or older who live in elderly care homes by counties in Croatia in 2023

After the City of Zagreb, the highest number of county care homes, with 4 each, are found in Primorje-Gorski Kotar, Split-Dalmatia, Istria, and Dubrovnik-Neretva County. Although these are economically developed counties, the number of people aged 65+ institutionally cared for is below the Croatian average. Alongside the 5 private homes in Primorje-Gorski Kotar County, only 2.0% of the total number of people aged 65+ are accommodated. The percentage of people aged 65+ in institutional care is even lower at 1.8% in Split-Dalmatia County, with 8 private homes, and 1 private and 2 state-owned homes in Dubrovnik-Neretva County. In Istria County, 2.3% of the population aged 65+ reside in 4 private and 4 county care homes. Following them is Osijek-Baranja County with three county care homes and 7 private homes accommodating 2.6% of the population. Two county care homes are present in Šibenik-Knin, Sisak-Moslavina, Požega-Slavonia, and Vukovar-Srijem County. One each in Karlovac, Varaždin, Koprivnica-Križevci, Lika-Senj, Brod-Posavina, and Zadar County. Zagreb, Krapina-Zagorje, and Virovitica-Podravina County have no county care homes. Therefore, Zagreb County has 16 private homes where 3.2% of the population aged 65+ reside. In 6 private homes in Krapina-Zagorje

County, 3.3% of the elderly reside, and in 5 private homes in Virovitica-Podravina County, 2.6% reside.

A study on the availability of institutional care for the elderly across counties and social programs for the elderly in four local government units confirmed that the level of realization of social rights depends on two parameters - place of residence (county) and socioeconomic status (Babić, 2017). Research on the needs of older adults for social care services in Croatia confirmed differences in the need for formal care forms based on the size of the place where individuals live (large or small city) (Penava Šimac et al., 2022). The same study showed that in larger cities, more users express a desire for accommodation in elderly care homes, for organized daily activities, and for home care services (Penava Šimac et al., 2022: 201).

In Croatia, almost all state and county-owned homes are located in urban areas. A similar situation exists with private homes as well. Namely, almost all county homes were built during a period when rural areas had already significantly depopulated, so there was no financial interest in building care homes, and often there was also a lack of professional workforce to work in the institution (Podgorelec, 2008). At the same time, care and support for an elderly family member, especially a spouse or parent, were almost unquestionable. Entrusting care to an institution was considered a shame for the family (Babić et al., 2004, Podgorelec, 2008). The traditional reliance on informal caregivers in rural areas persists today, although modern lifestyles impose new values, thus organized formal care is increasingly accepted both by older family members and by the local community (Podgorelec & Klempić Bogadi, 2013).

CONCLUSION

Despite contemporary trends advocating primarily for healthy and active ageing, i.e., the prolonged maintenance of independence for older persons and living in their own homes, Croatia's rapidly ageing population requires good organization and a balanced relationship between formal care institutions and informal caregivers. The intensity of ageing, coupled with an increasing share of the vulnerable elderly group aged 80 and above, who largely require assistance, and whose numbers have doubled in the last twenty years, varies across regions.

From the analysed data, it is noticeable that differences in the possibilities of institutional care provision are continuously increasing in the organization of formal care forms, mainly in terms of the level of economic development. Counties more exposed to strong emigration, sparsely populated, with a higher proportion of population primarily engaged in agriculture, are the counties with a higher number of older people, higher proportion of single-person households, lower GDP, higher poverty risk rate, and less organized forms of institutional accommodation.

Part of the problem is that almost all homes funded by counties and which, due to their cost, can be considered affordable for the majority of Croatian retirees today, were built during the planned economy period, until 1990. With the change in the political system in 1991 and the transition to a market economy, institutional care increasingly shifts to the private sector. Private homes have largely replaced the need for caring for the elderly, reducing long waiting lists. The problem is that accommodation prices and accompanying services are not always adequately aligned. Similar public policies for elderly care in nursing and care institutions have

been observed in various degrees in other European countries, especially former socialist countries, since the mid-2000s.

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EXPLORING PREFERENCES AND TOURIST TYPES VISITING OHRID

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ABSTRACT

Tourism policymakers can gain crucial insights and identify innovative strategic approaches by understanding tourists' perceptions. This study, focusing on tourists visiting Ohrid, the most famous tourist destination in North Macedonia, delves into three key factors: (1) Place attachment; (2) Pull motives; and (3) Experiencing. Conducting a survey from June to July 2022 with 250 foreign tourists, we aimed to identify and categorize their tourist images based on the standard classification of tourist typology. The study highlights that tourists predominantly perceive Ohrid as a historic and legendary destination, with cultural heritage emerging as the primary pull factor. Recreational tourists constitute the dominant group visiting Ohrid based on their type of experience. Furthermore, the study identifies gender as the most independent variable, followed closely by education, while variables such as age, marital status, type of visitor, and frequency exhibit complete statistical dependence. In conclusion, the findings offer valuable insights into the segmentation criteria recommended for defining the tourism development strategy for Ohrid.

Keywords: Tourist perceptions, Tourist type, Tourism development, Ohrid

INTRODUCTION

While tourist motivation has been extensively studied, there is a relative scarcity of research exploring the influential factors that shape tourists' perceptions and images. This study aims to address this gap by focusing on understanding tourists' perceptions during their experience in Ohrid, North Macedonia. The primary goal is to uncover prevailing perceptions, shedding light on the intricate world of tourists as they form diverse images of the destination.

In contrast to previous research that delved into residents' perspectives on tourism impacts in Ohrid (Petrevska & Mihalič, 2020; Petrevska et al., 2020, 2023), this study is dedicated to unraveling the creation of the tourist image of Ohrid from the viewpoint of tourists themselves. Given the limited existing academic research on tourist perceptions of Ohrid (Petrevska, 2018, 2019; Petrevska & Matlievska, 2018), this paper contributes to expanding the current literature. It aids in recognizing the factors that significantly influence the development of a tourist destination, especially one with historical and religious significance like Ohrid, already established as a cultural center. The practical significance of this paper lies in its potential to serve as a valuable starting point for the development of new strategic approaches supporting the tourism growth of Ohrid.

In terms of organization, the paper proceeds with a literature review on tourist typology and provides essential background information about Ohrid in Section two. Section three outlines the applied methodology, followed by the presentation of findings and their discussion in Section four. The conclusion wraps up the paper, summarizing the key insights derived from the research.

LITERATURE REVIEW

The literature extensively covers the subject of tourist roles, aiming to delineate their significant variations. Primarily, behavioral patterns are linked to specific demographic and background characteristics, with a particular emphasis on the life course as the principal component for examining tourist role preferences. However, it is crucial to consider various social structures and processes, including psychological needs and life-course stages. Cohen (1972) was among the first sociologists to propose a typology, developing a four-fold typology to conceptually clarify the term "tourist." A few years later, he expanded the list to a five-group classification based on the type of experience sought (Cohen, 1979).

Pearce (1982) identified specific behavior that connects the evolutionary nature of tourist role preferences with psychological needs. He went on to develop 15 distinct tourist types, facilitating the creation of several measurement scales. The Tourist Roles Preference Scale (Yiannakis & Gibson, 1992) presents a comprehensive classification of leisure tourists. Additional contributions expanded the tourist categorization by adding two more tourist types (Gibson & Yiannakis, 2002). An earlier work related to the Yiannakis and Gibson (1992) typology is acknowledged by Mo et al. (1992), who designed the International Tourist Role scale. Using this scale, Keng and Cheng (1999) and Jiang et al. (2000) found a correlation between novelty-seeking and the choice of tourist role. Furthermore, Ryan and Glendon (1998) offered a cluster analysis derived from the Leisure Motivation Scale introduced by Beard and Ragheb (1983).

Subsequently, researchers delved into exploring the experiences of tourists and the significance of the tourist experience for them (Yfantidou et al., 2008). Additionally, there was a focus on classifying tourists based on the degree of novelty and familiarity sought (Lepp & Gibson, 2003).

BACKGROUND MATERIAL

Ohrid, located in North Macedonia, has a population over 52,000 residents and stands as the most popular summer tourist destination in the country. Acknowledged as a transboundary mixed world heritage site under UNESCO protection, Ohrid is known for the natural exceptional value of Lake Ohrid (UNESCO, 1979) and its cultural and historical significance (UNESCO, 1980). It possesses numerous historical monuments, natural resources, gastronomy, and numerous cultural events, which generally constitute the basis for attracting tourists. Ohrid is recognized for its remarkably preserved authentic architecture, positioning it as one of the most comprehensive collections of ancient urban architecture in the region (UNESCO, 2019).

With a typical profile of a summer tourism destination characterized by strong seasonality (Petrevska, 2015), Ohrid played a substantial role in the tourism landscape of North Macedonia in 2023. It accounted for nearly one-third of all tourist arrivals (337,138) and overnights

(1,144,000) recorded in the country (State Statistical Office of the Republic of North Macedonia, 2024).

While tourism serves as the primary industry for local growth and development, it often brings about negative impacts and significant degradation of the physical, environmental, and social capacities of the destination (Petrevska & Collins-Kreiner, 2017, 2019). Consequently, UNESCO has raised concerns about the need for responsible and sustainable tourism practices in Ohrid, even considering the inclusion of the site on the List of World Heritage in Danger (UNESCO, 2019). This emphasizes the urgency highlighted by researchers advocating for responsible tourism in Ohrid (Petrevska & Mihalič, 2020; Petrevska et al., 2023).

METHODOLOGY

The research employed both qualitative and quantitative methods. The qualitative aspect involved a literature review. The quantitative aspect included a face-to-face survey on 250 foreign tourists visiting Ohrid from June to July 2022, achieving an impressive response rate of 95.5%. The questionnaire was translated into English, and the survey was conducted in the large surrounding of the St. Naum monastery, a prominent location highly frequented during the summer season, situated 30 km from Ohrid near the border with Albania.

The survey instrument utilized a self-administered fixed-choice questionnaire. Respondents employed a five-point Likert scale (1=strongly disagree to 5=strongly agree) to assess the importance of each factor. The questionnaire was organized into four sections as follows:

- Section 1 gathered respondents' data, comprising eight questions related to gender, age, marital status, education, occupational status, type of visitor, type of holiday, and frequency of visit.
- Section 2 encompassed three questions focused on place attachment.
- Section 3 included three questions aimed at identifying 'pull' motives, and
- Section 4 consisted of five questions related to the perception of the tourist experience;

The collected data were then input into a common scorecard database in SPSS 24.0 for statistical evaluation. Descriptive statistics and nonparametric statistical tests were utilized to create an initial tourist typology. To explore potential relationships between variables, the Chi-Square test ($\chi 2$) for independence was calculated.

FINDINGS AND DISCUSSION

The discussion of the findings unfolds in two main aspects:

Firstly, we present general and specific data findings related to the demographic attributes of respondents, along with key insights into their perceptions of place attachment, pull motives, and experiencing.

Secondly, we delve into the statistically significant associations between general data variables and specific data variables through cross-tabulations.

In examining the demographic attributes of respondents, a slight gender difference is noticeable, with 54% being female and 45% male. The age distribution reveals that the majority fall within the 30-49 years age group (43%), followed by those aged 50 and over (32%), and the

youngest group (20-29 years) accounting for 25%. Regarding marital status, the majority of respondents are married (63%). A significant proportion of participants hold a university diploma (69%) and are employed (69%).

Given that the survey took place at a very famous tourist location St. Naum, which also serves as a religious site, a question about the type of visitor was included. Notably, 71% identified as tourists, while 10% fell into the category "other" without clarification, and 18% declared themselves as pilgrims. A significant majority (70%) of respondents were individual tourists on self-organized visits, while 30% were on tours arranged by travel agencies. In terms of frequency, most respondents had visited Ohrid more than five times, but approximately one-third were first-time visitors.

The second section of the questionnaire explored place attachment through three questions. The findings indicate that tourists primarily perceive Ohrid as a historic and legendary place, followed by its religious significance. However, a notable divergence arises when considering Ohrid as solely a tourist destination for sightseeing, with 31% of respondents disagreeing.

Section 3 focused on 'pull' motives, identifying cultural heritage, religion, and sightseeing as key factors attracting tourists to Ohrid. Cultural heritage emerged as the primary attraction, with 64% strongly agreeing or agreeing that it brought them to the location. In contrast, 55% strongly disagreed or disagreed with coming for religious reasons, while almost one-third (30%) strongly agreed they came solely for sightseeing.

Section 4, based on Cohen's (1979) classification, addressed the tourist types with five questions. The revealed recreational tourists as the dominant group (38.2%). They are drawn to Ohrid for physical recreation, aligning with the destination's emphasis on sun, lake, and leisure. Following closely are existential tourists (29.8%) who seek cultural immersion, strongly agreeing that they visit Ohrid to delve into its rich cultural heritage. This finding affirms the widely acknowledged notion that Ohrid serves as a cultural cradle, attracting tourists with a penchant for cultural experiences. Experiential tourists trail slightly behind (26.2%), motivated and inspired by the unique qualities of the surveyed location. This aligns with expectations, given that experiential tourists typically seek authentic experiences, and Ohrid and the sampled location, fulfill this criterion. Next in line are experimental tourists (23% strongly agreed, 27.7% agreed), who like interacting with local people. They are drawn to Ohrid's rich history, artistic spirit, and traditional crafts such as woodcarving, jewelry making, pearl crafting, pottery, coppersmithing, and shoemaking. Remarkably, the research identified the absence of diversionary tourists, those seeking an escape from daily life.

The study also conducted cross-tabulations, uncovering sufficient evidence to suggest associations between general data variables (gender, age, marital status, education, occupational status, type of visitor, type of holiday, and frequency of visit) and specific data variables. Statistically significant associations were observed in the following areas:

- Regarding gender, both male and female foreign tourists do not equally favor the same pull motives.
- Age, categorized as 20-29, 30-49, and 50 years and over, revealed differences among three categories of tourists (recreational, experiential, and experimental), with only two exceptions (existential and diversionary types of tourists).

- Marital status, categorized as married, single, divorced, with a partner, and other, showed differences across all investigated issues.
- Types of education, categorized as elementary, high school, and university, were correlated with recreational, diversionary, and experiential types of tourists. Education also had an association only with cultural heritage as a pull motive.
- Occupational status, categorized as student, employed, unemployed, and retired, correlated with all specifically investigated issues.
- Type of visitor was generally related to all specific issues, with no significant difference between respondents declaring themselves as pilgrims, tourists, or 'other'. Visiting Ohrid individually (self-organized) or in a group (by travel agency) was related to almost all questioned issues.
- Frequency of visit, whether it was the first time, second time, 3-5 times, or more than five times, influenced the creation of a tourist image, indicating an association between the variables.

In analyzing the independence of variables, it was observed that gender is the most independent variable, followed by education, type of holiday, and occupational status. On the other hand:

- Gender is significant when it comes to the experiencing aspect.
- The type of education is significant when it comes to place attachment.
- Occupational status and the type of holiday (individual or group) are significant when it comes to all investigated factors, including the perception of place, pull motives, and experiencing.

Moreover, based on established correlation patterns, the research identified that variables such as age, marital status, type of visitor, and frequency are statistically dependent categories. This implies that tourism policymakers should consider these criteria when creating tourism policy and strategy for the development of tourism in Ohrid.

CONCLUSION

Conducting an extensive survey involving 250 foreign tourists, this research aimed to construct a tourist image of Ohrid by exploring tourist typology and three key factors influencing perception: (1) Place attachment; (2) Pull motives; and (3) Experiencing.

Drawing insights from Cohen (1979) on tourist typology, the study revealed that recreational tourists constitute the predominant group visiting Ohrid. This aligns with prior research (Petrevska, 2018, 2019), indicating Ohrid's reputation as a destination primarily offering leisure and the enjoyment of sun and lake. The second-ranked type, existential tourists, visit Ohrid for its cultural heritage, echoing the city's portrayal as a cultural cradle, one of the oldest human settlements in Europe, with 365 churches, often referred to as the "Jerusalem of the Balkans" (Vankovska & Wiberg, 2003; Petrovski & Talevski, 2004). The experiential tourist, the third-ranked type, is drawn to the authenticity, uniqueness, and inspiration of the destination. This preference aligns with the authentic urban architecture of Ohrid (Kuzman et al., 2009; Panevski Nikoljski & Karanakov, 2013) and the exceptional blend of natural and geographic values that create a rare harmony, making the Lake Ohrid region truly unique (UNESCO, 2019).

The fourth-ranked experimental tourist is triggered by the local lifestyle, showing an interest in learning about local people and crafts. Ohrid's renown for traditional handmade products, such as woodcarving, jewelry, pearl making, pottering, coppersmiths, and shoemakers, caters to this type. However, the research found no presence of a diversionary tourist type seeking an escape from everyday life.

Moreover, beyond exploring the experiential factor and identifying tourist types visiting Ohrid, the research delved into place attachment and pull factors as triggers influencing tourists' perception. Regarding place attachment, Ohrid is generally perceived as a historic and legendary destination, transcending mere touristic appeal. In terms of main pull motives, cultural heritage emerged as the primary factor, challenging the perception of Ohrid as a religiously fulfilling destination and positioning it as a sightseeing hotspot.

The study also examined the association between general and specific data variables. Cross-tabulations confirmed statistically significant associations between dependent variables (age, marital status, type of visitor, and frequency) and independent variables (gender, education, occupational status, and type of holiday). Gender emerged as the most significant independent variable influencing the creation of tourist perceptions related to experiencing. Education (categorized as elementary, high school, and university) played a role in place attachment and cultural heritage as pull motives. Occupational status (categorized as student, employed, unemployed, and retired) and the type of holiday (individual or group) influenced all investigated factors, i.e. perceptions of place, pull motives, and experiencing.

Conversely, the research identified strong statistical dependency among dependent variables. This suggests that (categorized as 20-29, 30-49, and 50 years and over), marital status (categorized as married, single, divorced, with partner, and other), type of visitor (traveling individually i.e. self-organized, or in a group by travel agency), and frequency (visiting Ohrid for the first time, second time, 3-5 times, or more than five times), should be considered as robust segmentation criteria when defining the tourism development strategy of Ohrid. In conclusion, this research underscores the importance of aligning tourism supplier expectations with the imaging and perceptions of tourists.

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TYPOLOGY OF MUNICIPALITIES BY ITS POPULATION SIZE – THE CASE OF NORTH MACEDONIA

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ABSTRACT

The focus of research in this paper is directed toward the change in the number of the population as one of the many variables that determine the demographic resources of a specific area.

The demographic potential analyzed in terms of the change in the population and its spatial distribution is studied at the level of local self-government units i.e., municipalities. This potential is presented through the analysis of selected indicators related to the dynamics of the population number and population density. Based on the population Census 2021 data analysis and compared to the previously conducted censuses, the spatial differentiation of municipalities by its population size has been determined, that is the spatial disparities of the unfavorable dynamics in the population number.

All of these changes came as a result of the negative demographic processes. Namely, the multi-year negative demographic trends that marked the past period, first of all, the reduced natural population change and the increased emigration, had a serious impact on the population decline in the municipalities and contributed to a serious reduction and narrowing of the basis of the demographic potential at their disposal. A large part of the municipalities show a distinctly unfavorable situation regarding the change in the population as a fundamental part of the demographic potential which is insufficient for their demographic and economic development. At the same time, this changes the utilization of the demographic potential in other segments, such as education and other service activities, production, etc.

The main aim of this analysis is to identify and valorize the demographic potential and its impact on the organization and functional development of the space and the sustainable development of municipalities in general.

Keywords: Population number, population density, demographic potential, disparities

INTRODUCTION

The population characteristics of a particular area have inestimable importance for understanding the development processes and changes that are taking place. Those characteristics along with the natural-geographical and socio-economic peculiarities, are the determinants that condition and direct the development of spatial entities in the country.

The number, structure, and spatial distribution of the population are conditioned by the components of the population dynamics (natural population change and migration), but the

action of a large number of diverse factors, including the physical-geographic characteristics of the specific area, the level of economic development, the infrastructural equipment, the institutional capacities and their development, etc., play an important role as well.

The population and its spatial distribution, in addition to the multifunctional significance they have, form the demographic basis for the administrative-territorial organization of the space. At the same time, the population and the changes that mark its development form the spatial-demographic characteristics and specificities of the territorial units. The Republic of North Macedonia, considering the natural-geographical and socio-economic conditions in which it developed, is distinguished by peculiarities in terms of its spatial-demographic characteristics, expressed through differences in terms of population density, the population size of settlements and municipalities, the settlement status, their administrative function and so on. All those characteristics contribute to the number and size of municipalities, the differences in terms of demographic resources and potentials of municipalities, their importance in spatial development, etc.

Taking into account all the determinants of demographic development, it is obvious that the Republic of North Macedonia is distinguished by great contrasts in terms of population distribution and concentration. Mainly, larger municipalities with headquarters located in urban settlements appear as centers of concentration, while smaller municipalities (mainly rural, but some urban as well) are characterized by a lower concentration of population.

From a demographic point, the overview of municipalities by their population size gives a certain idea about the needs of the local self-government units. Among other things, it indicates the demographic factor for the development of certain activities.

METHODOLOGY AND DATA SOURCES

The focus of the research in the paper is directed at understanding the changes in the population size of the municipalities from 2002 to 2021, which is the last inter-census period.

Namely, the changes in the administrative-territorial organization of the local self-government units, marked by changes in the number and size of municipalities from a population and territorial perspective, complicate the possibility of comparing census data. In order to improve the municipalities' sustainability in the past period, more reorganizations of the local self-government units occurred and the number of municipalities changed, and thus their size in terms of population and area changed as well.

However, the practice has shown that the large number of municipalities that were set with the administrative-territorial organization in 1996, that is a total of 123, is unsustainable in reality. In the last inter-census period, the number of municipalities changed from 84 in 2004 to 80 in 2013. With the Law on Amendments to the Law on Territorial Organization of Local Self-Government adopted in August 2008, the merger of the municipalities of Vraneshtica, Drugovo, Kichevo, Oslomej, and Zajas into one municipality, i.e. the municipality of Kichevo, was postponed until 2013 (Official Gazette of the Republic Macedonia, No. 98/2008) (Ljakoska, Madjevikj, 2017).

All those changes to a certain extent complicate and limit the comparability of data between census years at the municipality level (NTES 4). The reduced number of municipalities

in a simpler way makes it possible to obtain greater data comparability from a territorial aspect, and those were the reasons that the research in the paper refers to the period between the last two censuses.

The research is based on a huge fund of statistical data from relevant sources, primarily the statistical data from the Censuses of the population, households, and dwellings conducted so far, regular statistical surveys, as well as from other sources. It is important to point out that there are certain methodological differences in the data from different census years in terms of total population definition, i.e., resident and nonresident population.

The 2021 Census data refers to the resident population, which includes 132,260 persons for whom data was obtained from administrative sources, and their characteristics are not well known. It directly reflects the quality of the obtained indicators, thus influencing the representation of the change that has occurred at the national, regional, and local levels.

Thus, this paper offers a typology of the current number of municipalities by their population size for 2002 and 2021 which clearly shows the changes in the structure of the municipalities by their population number and the trend of population relocation from smaller municipalities towards more populated ones.

The issue of changes in the municipalities number, status, their development regarding the population number and distribution, economy and so on, have been elaborated as part of other complex geographic researches, by a numerous author in the country. In the papers by Daskalovski can be found analyses on the spatial determinants of the population development, and distribution, with a special focus on the population from rural areas, etc., (1985; 1987; 1989; 1995; 1996; 1999; 2002), about the process of demographic and economic polarization in the country, Madzevikj et. al., (2013), about the demographic changes in the Skopje region analyses have been made by Apostolovska Toshevska et. al, (2017), analyses about the regional disparities, Iliev (2019), etc.

RESULTS AND DISCUSSION

Changes in the population size

The changes in the population size, its structure, and spatial distribution are of exceptional importance for understanding changes and processes in a particular area because they represent one of the key determinants on which the overall development of the country depends. The demographic changes determine and direct the spatial distribution of all aspects of human activity. The changes in the population number come as a result of the demographic processes that took place in the past, but they also represent a basis for planning the organization of space in the future. Rational space organization is impossible without understanding the changes in the number of the population and its administrative-territorial distribution and organization. The changes in the population number in the past period were characterized by an increasing tendency in all inter-census periods, except for the period 2002-2021. The largest positive change was observed in the period 1961-1971, when the population registered an increase of 17.16%, while in the inter-census period 1971-1981, it was 15.89%. When analyzing data from the censuses after the one of 1981, the methodological differences regarding the definition

of the total population, the application of the term resident population, and so on, should be taken into account.

The changed methodology in the 1994 census, when a person who has been absent from the country for a year or more is not included in the total population, resulted in a slowdown of the growth of the total population. In the period 2002-2021, the population decreased by 185,834 people (9.18%). The negative changes, first of all, came as a result of the continuous reduction of the natural increase, the decrease in births, the increase in mortality, as well as the intensive emigration movements.

Table 1. Population in the Republic of North Macedonia by the census data (1948-2021)

Year	Total population	Change in number	Change in %
1948	1152986	-	-
1953	1304514	151528	13,14
1961	1406003	101489	7,78
1971	1647308	241305	17,16
1981	1909136	261828	15,89
1994	1945932	36796	1,93
2002	2022547	76615	3,94
2021	1836713	- 185834	- 9,19

Source: SSO (2004): Census of the population, households, and dwellings in the Republic of Macedonia. Total population, households, and dwellings by the territorial organization of the Republic of Macedonia from 2004. Book XIII. Skopje; https://makstat.stat.gov.mk

The dynamics in the population number at the national level are followed by changes in the number of the population at the level of the local self-government units, i.e. the municipalities. The last census data (2021), point to serious population losses that occurred in the country, a change in the number of the population in municipalities, but also a change in the size of settlements.

Due to most of the changes in the administrative-territorial organization of settlements and the different number of municipalities in the past, it is difficult to make precise data comparisons for several inter-census periods. Those reasons pointed to the need for a more detailed analysis regarding the population number at the level of the local self-government units for the last inter-census period.

The data analysis points to serious population changes that occurred in the municipalities, most often marked by negative tendencies in the population dynamics. Some of the municipalities are characterized by population growth, others by stagnation or decrease.

An increase in the number of the population was recorded in 14 municipalities, which represents 17.5% of the municipalities in the country. Most of those municipalities are part of the City of Skopje (except the municipalities of Gazi Baba, Centar, and Chair), Chucher Sandevo, Chashka, Studenichani, Sopishte, Petrovec, Ilinden, Arachinovo and Shuto Orizari. The municipalities of Studenichani (27.4%) and Sopishte (18.7%) have the largest increase.

In the rest of the municipalities, there is a stagnation or decrease in the number of the population. Some of the municipalities suffered large population losses of over 30%. The municipalities with the largest decrease in their population are Centar Zhupa (-43%), Mavrovo and Rostusha (-41.5%), Novo Selo (-39.7%) and Zrnovci (-36.1%).

This speaks enough about the size of the population losses of the municipalities and the reduced demographic potential.

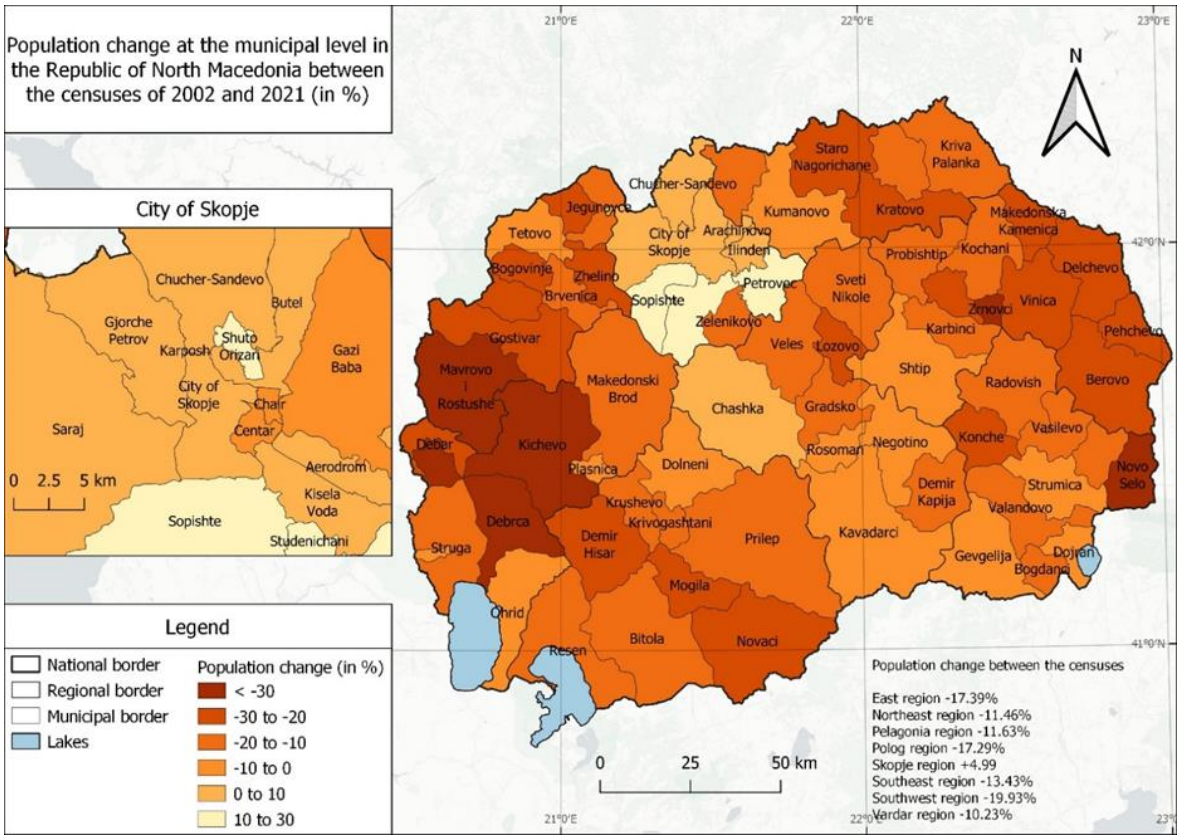

Figure 1. Population change at the municipal level in the Republic of North Macedonia, 2002-2021 (in %)

Typology of municipalities by their population size

Settlements represent territorially organized units, areas where the life of the population takes place. Considering the diverse human needs, and in the direction of better organization and functionality, the settlements are united in higher-level administrative-territorial units, which are the municipalities.

Furthermore, municipalities can be grouped into complex territorial units such as micro, meso, and macro-regions, etc. Municipalities, as local self-government units, are formed based on appropriate principles, and within their frameworks, a different number of settlements that have different population sizes, cover different areas and have various natural-geographic and socio-economic specificities are included.

Analogous to all that, the administrative-territorial organization of the local self-government units has undergone many changes in the past, basically changing the grouping of settlements in specific municipalities and thereby changing the number of municipalities in the country or at the level of regions. However, what cannot be missed is that for a good part, the municipality structure consists of very small municipalities by its population size and does not hold the capacity to maintain its basic functions.

In Table 2 are presented the 2002 and 2021 census data for the population size of municipalities according to the current administrative-territorial organization.

Table 2. Distribution of municipalities by their population size in 2002 and 2021

	2002				2021			
Size Group	municipalities		population		municipalities		population	
Population number	number	%	number	%	number	%	number	%
Less than 5000	**14**	17,5	53130	2,6	**17**	21,3	55363	3,0
5001-10000	**16**	20,0	119727	5,9	**16**	20,0	112692	6,1
10001-20000	**19**	23,8	286883	14,2	**19**	23,8	279699	15,2
20001-30000	**9**	11,3	222367	11,0	**6**	7,5	138614	7,5
30001-50000	**7**	8,8	283237	14,0	**10**	12,5	415432	22,6
50001-70000	**8**	10,0	467318	23,1	**8**	10,0	489140	26,6
70001-100000	**6**	7,5	484401	24,0	**4**	5,0	345773	18,8
More than 100000	**1**	1,3	105484	5,2	**0**	0,0	0	0,0
Total	**80**	**100,0**	**2022547**	**100,0**	**80**	**100,0**	**1836713**	**100,0**

Source: Authors calculations using SSO data; https://makstat.stat.gov.mk

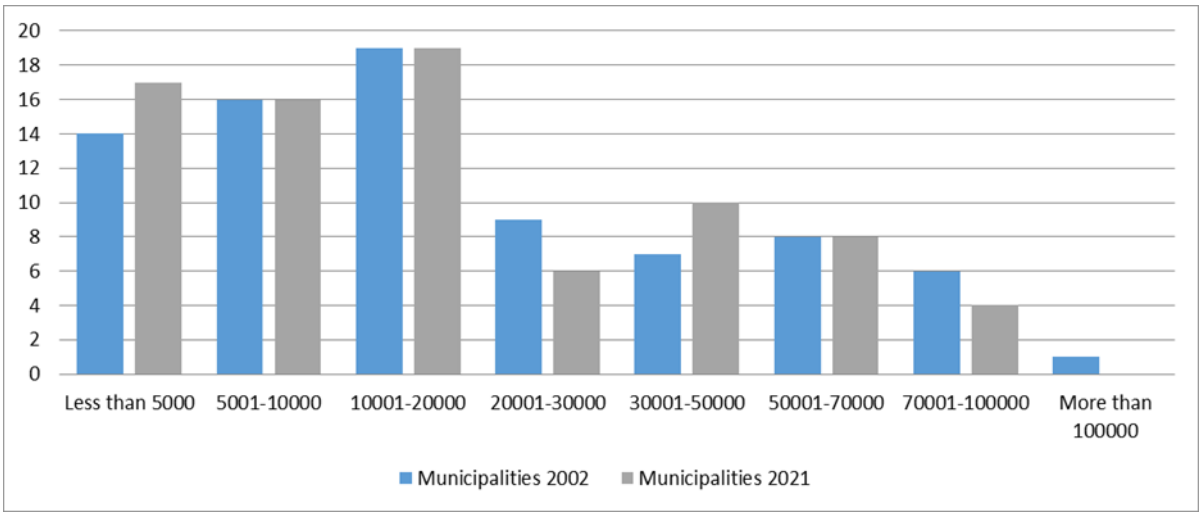

Figure 2. Municipalities groups by their population size, in 2002 and 2021

The average population size of the municipalities in 2021 was 22,959 inhabitants which is 2,323 inhabitants less compared to 2002. Then, the average population size was 25,282 inhabitants. If we analyze 2002 census data by the then-existing administrative-territorial organization which counted for 84 municipalities, the average municipality size would be somewhat smaller i.e., 24,078 inhabitants.

Table 3. Municipalities average population size in 2002 and 2021

Population number	Average municipality size		2021/2002
	2002	2021	
Less than 5000	3795	3257	85.82
5001-10000	7483	7043	94.12
10001-20000	15099	14721	97.50
20001-30000	24707	23102	93.50
30001-50000	40462	41543	102.67
50001-70000	58412	61142	104.67
70001-100000	83733	86443	103.24
More than 100000	105484	0	0
Total	**25282**	**22959**	**90.81**

Source: Authors calculations using SSO data; https://makstat.stat.gov.mk

The more detailed analysis of municipalities' average population size, shows a decrease in the number of municipalities with up to 30,000 inhabitants, while this number increased in other categories, with the highest values for the municipalities that counted for 50,001 to 70,000 inhabitants.

The reason for the reduction of the municipalities' population size can be seen in the reduction of the country's population, conditioned by the intensive emigration and the decrease in the birth rate followed by the increase in the population mortality rates. In that regard, the smaller municipalities that are mostly rural, that is, do not include an urban settlement within the municipality borders, stand out.

There is a huge difference among municipalities when it comes to their population size. The smallest is the municipality of Zrnovci with 2,086 inhabitants, while the largest is the municipality of Kumanovo with 98,104 inhabitants, which makes it 47 times larger than the smallest municipality.

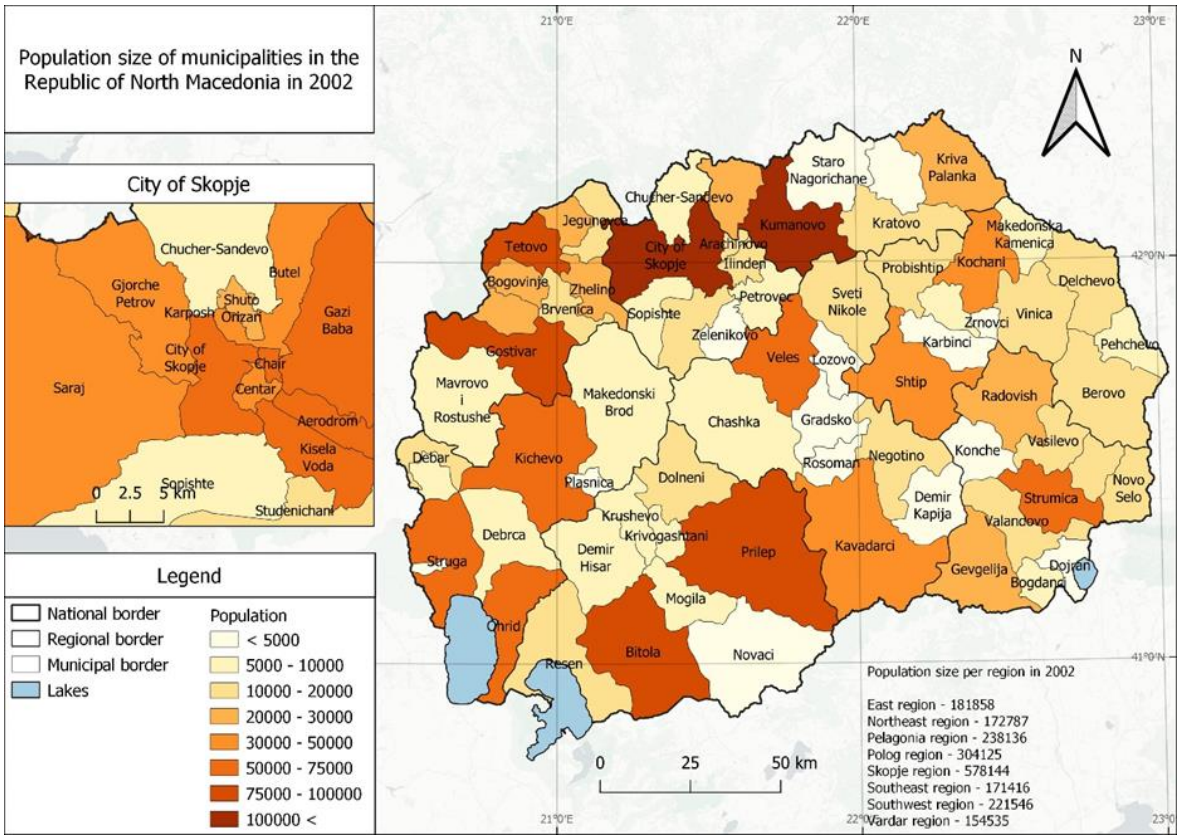

Figure 3. Population size of municipalities in the Republic of North Macedonia in 2002.

The Census data shows that in the municipalities' structure, the most dominant are the less populated municipalities. The group of small municipalities with up to 5,000 inhabitants includes 17 municipalities to the 2021 census data. Even five municipalities of this group have less than 3,000 inhabitants, 11 municipalities are populated with 3,000 to 4,000 inhabitants, and only the municipality of Plasnica counts for over 4,000 inhabitants. The fact that they represent 21.3% of the municipalities, populated with only 3% of the total population in the country, speaks of the unfavorable demographic situation in the smallest municipalities with up to five thousand inhabitants.

The municipalities with 5-10,000 and 10-20,000 inhabitants are represented with a similar percentage share, but are in somewhat better demographic condition, at least by its population size. In the group of municipalities with 5,001-10,000 inhabitants, the smallest is the municipality of Mavrovo and Rostushe with 5,042 inhabitants, while the largest is Cucher Sandevo with 9,200 inhabitants. In this group, one-half of the municipalities have up to 7,000 inhabitants, and the other half are populated with over 7,000 inhabitants.

The municipalities with 10,001-20,000 inhabitants are the most represented, and more than half of them (58%) count for more than 15,000 inhabitants.

The rest of the municipalities together, represent only 35% of the municipalities, but they include twice the population (75.5%) settled in the less populated ones. What is specific compared to 2002, is that the municipalities have undergone certain changes regarding their size, some of them have spilled over into another size group, smaller or larger, and there are no longer municipalities with more than 100,000 inhabitants. The number of the largest municipalities has dropped from six to four.

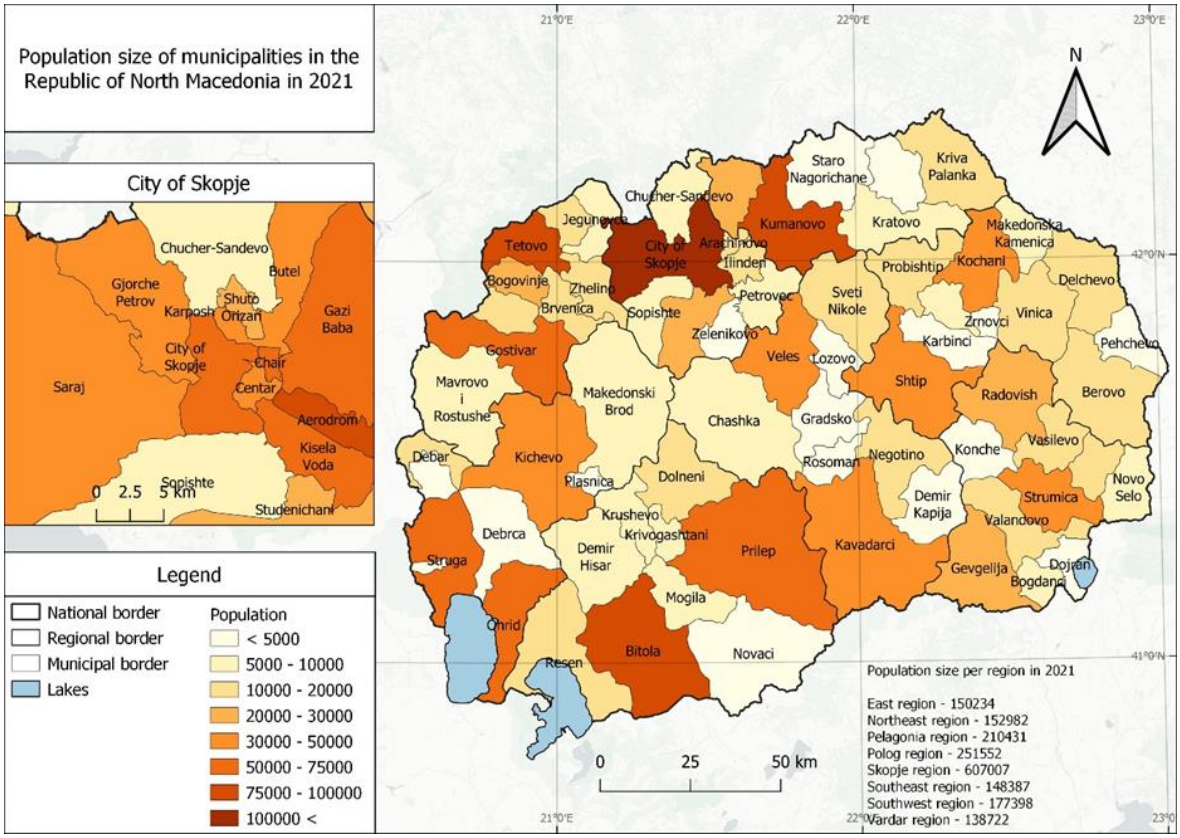

Figure 4. Population size of municipalities in the Republic of North Macedonia in 2021

The stated changes in the municipalities' size indicate the changes in terms of the potential that the municipalities have in terms of population, opportunities, and limitations. The increasing number of smaller municipalities, which absorb a small percent of the population in the country, as well as the tendency to reduce the average size of the municipalities, impose questions regarding the functioning and sustainability of the municipalities.

If the level of births is taken into account, the situation is more worrying. The analysis of the number of live births data for 2021, shows that on average, 233 children were born in each of the municipalities, which is 48 children less compared to the average of 2005. In half of the municipalities, less than 105 children were born, and in a quarter of them less than 39 children. The most unfavorable is the situation in the municipalities of Zrnovci and Novaci.

The low number of births, combined with an increase in mortality and emigration, further emphasizes the demographic problems in the smallest municipalities, but in the larger ones as well.

Municipal population density

The spatial distribution of the population is determined by the natural geographical factors of the specific area, the economic development, the infrastructure, and of course the population number. The distribution of the population depends on the number of inhabitants and it is directly proportional, and it is inversely proportional to the area of the settlement. This means that a larger number of inhabitants results in a higher population density and vice versa, and the larger the area of the settlement, the lower the density and vice versa (Bubalo Zivković, et al., 2012).

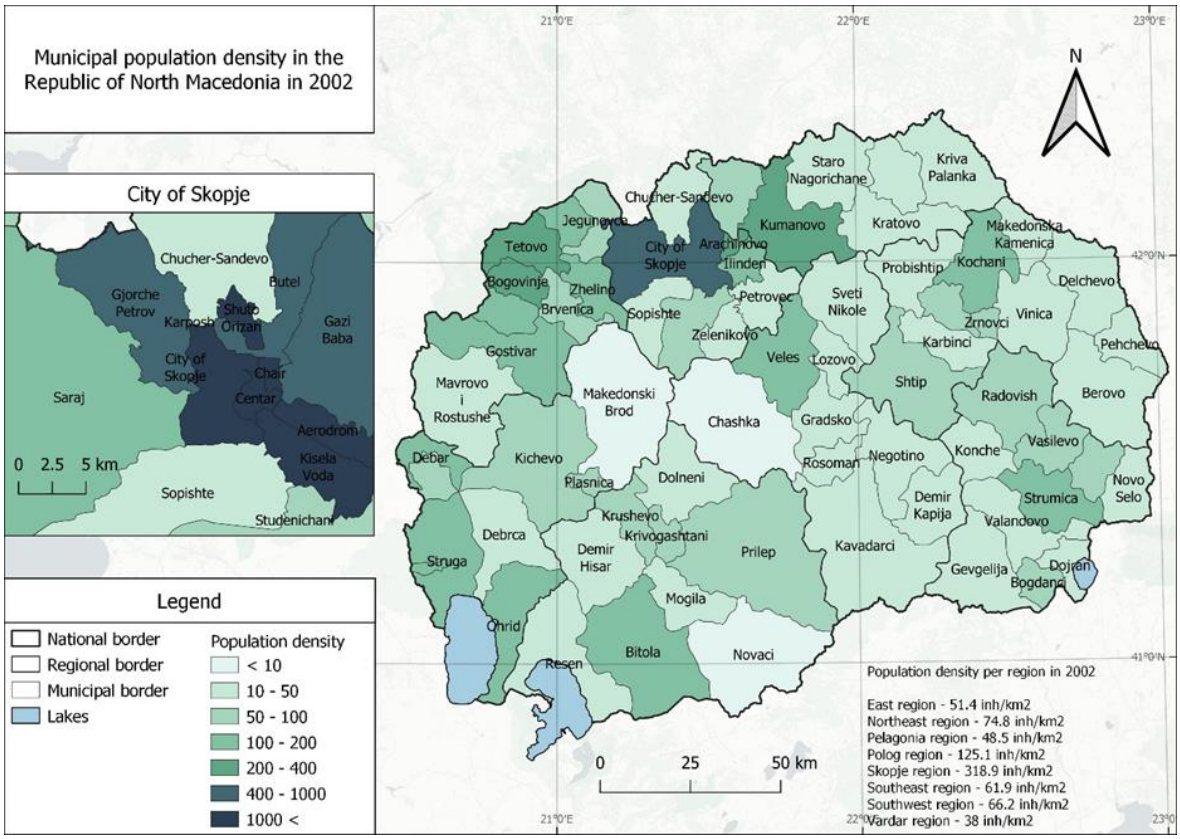

Figure 5. Municipal population density in the Republic of North Macedonia in 2002

The population number and its spatial distribution from a geographical aspect form the spatial-demographic characteristics and specificities of the territorial units. The Republic of

North Macedonia, considering the natural-geographical and socio-economic conditions is distinguished by peculiarities in terms of spatial-demographic characteristics, expressed through differences in terms of population density, population size of settlements, settlement status, their administrative function, and so on.

All those characteristics contribute to the presence of differences in terms of demographic resources and potentials of settlements, their importance in spatial development, etc.

On the changes of population density in some parts of the municipality, migrations had the greatest influence. Although the average population density in rural areas is the result of various components, the rule can be observed and that is that by furthering away from the city, the population density decreases, which resulted in a large difference in the population densities of certain rural areas (Mijanović, 2014).

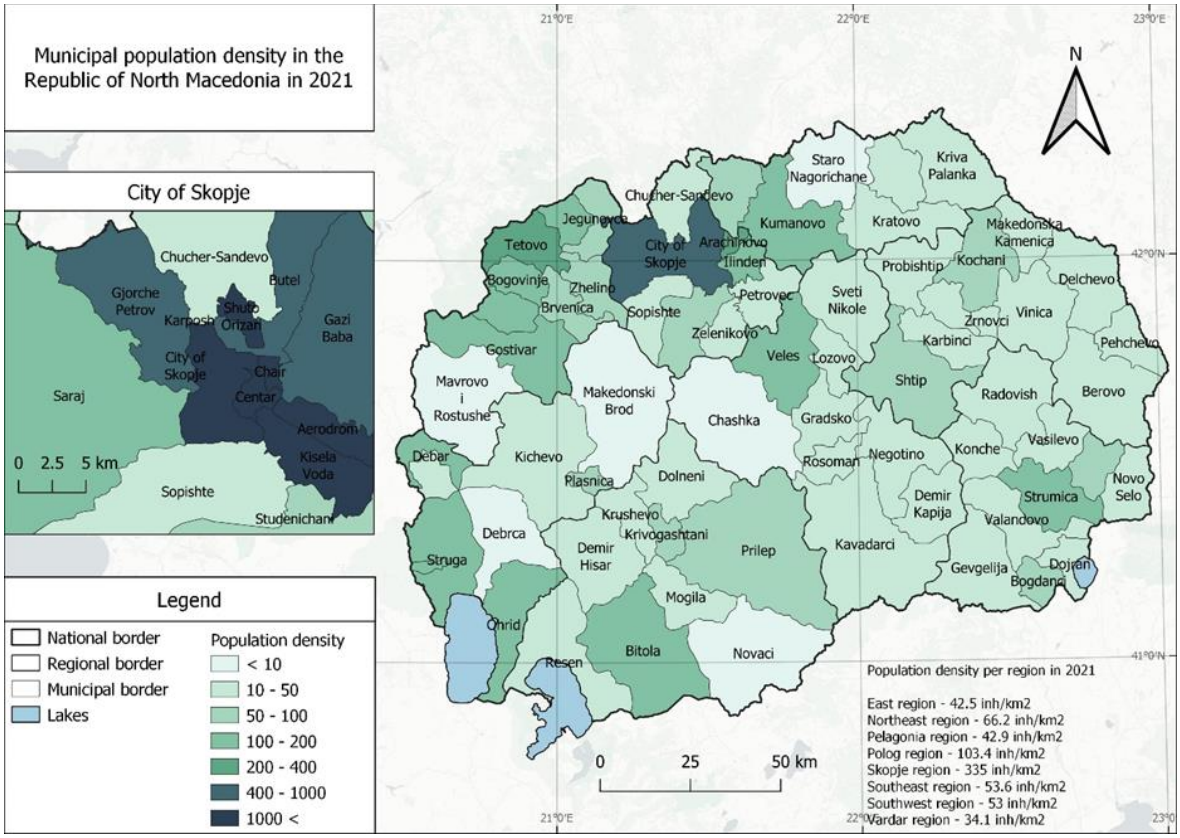

Figure 6. Municipal population density in the Republic of North Macedonia in 2021

Taking into account all the mentioned determinants of population distribution, the Republic of North Macedonia is distinguished by great contrasts in population distribution and concentration. Mainly, larger urban settlements are centers of population concentration, and rural areas have a lower concentration of population.

The large urban centers and the municipalities in the surroundings can attract the young population and thus influence the improvement of the demographic development of the population in that specific area (Bakić, Radić, 2017). On the other hand, this process can cause distinct limitations in terms of an even population distribution.

From a demographic point of view, it is interesting to analyze the general population density, which was 73 inh/km² in 2021, but also the regional differences in terms of population density, which in 2021 ranged from 34.1 inh/km² in the Vardar region, 103.4 inh/km² in the Polog region, to 335 inh/km² in the Skopje region (that is over four times more than the national average). The Skopje region is the only one that recorded an increase in population density from 2002 to 2021 and absorbed 33% of the total population in the country.

In the Skopje region, the municipality of Chair stands out with the highest population density in the country, i.e. 18,723.9 inh/km², followed by Centar with 5,830.9 inh/km², Aerodrom 3,681.3 inh/km² and Shuto Orizari 3,407.5 inh/km². In the Polog region, 4 out of 9 municipalities, are populated with over 100 inh/km², and Tetovo with a population density of 324 inh/km², stands out.

On the other hand, there are six municipalities (Chashka, Debarca, Makedonski Brod, Novaci, Mavrovo, and Rostusha, and Staro Nagorichane) with a density of less than 10 inh/km², among which only the municipality Makedonski Brod is an urban one. The category of municipalities with a density of up to 30 inh/km², includes eight cities, namely Kratovo, Resen, Pehchevo, Berovo, Demir Hisar, Demir Kapija, and Makedonski Brod. More than half of the municipalities had a population density of up to 60 inh/km².

Only four municipalities had a population density of 401 to 700 inh/km², and six municipalities (all in the Skopje region) were populated with over 700 inh/km².

Such a small population density in some of the municipalities is caused by the population decline in the last twenty years, mainly due to emigration.

Population density can be analyzed from several aspects, and if we consider it only as an indicator of population concentration, then it allows us to point out regions that have a more favorable, good, or unfavorable population concentration. The analyses of municipal population density give a certain representation, which is very significant for the local units' development needs. Even more, results can be obtained if the analyses of the population density are combined with other elements of the area (infrastructure, activities, job opportunities, etc.). That way can be created typologies for the government interventionism in municipalities such in the case of South African, which according to Van der Waldt (2015) are closely associated with the perceived purpose and role of government in a particular society. Namely, taking into consideration the degree of functionality (functional or dysfunctional) and the degree of interventions (low or high), four different types of interventions have been highlighted, that is: municipal support, recovery strategies and programs, section interventions and municipal mergers (Van der Waldt, Greffrath, 2016).

Another example on how the municipal population density can be used as the key criterion, is the one by the OECD. While the division line (threshold value) between rural and urban municipality was defined the value 150 inhabitants/km², municipalities with the population density below 150 inhabitants/km² are considered rural (Székely, 2016; Marot, 2010; Gligorijević, Devedžić, 2011).

If the OECD methodology is used in defining municipalities in North Macedonia for 2021, it will be noted that only 16 out of 80 municipalities can be placed in the category of urban. Even 12 of those municipalities are located in the Skopje region (Saraj, Ilinden, Arachinovo,

Gazi Baba, Gjorche Petrov, Butel, Karposh, Kisela Voda, Shuto Orizari, Aerodrom, Centar and Chair). Tree of the other four municipalities have a headquarters located in an urban settlement, while the headquarter of the forth municipality is located in a rural settlement, and not all of the rest municipalities that by using this methodology are considered as rural can be placed in this category considering their headquarters location. Therefore, with right, the OECD methodology is considered as imperfectly reflecting the rural character of areas (Hurbánek, 2008).

CONCLUSION

The emphasis of research in the paper is set on the changes in the number of the population in the local self-government units (NTES 4) in the inter-census period 2002-2021. The research results have shown the changes in the population number at the level of municipalities but also indicate serious problems in the development of the population from a spatial aspect.

These historical demographic changes caused the phenomenon of a dramatic decline in fertility on the one hand, while the medical innovations and the extension of life expectancy on the other hand, led to a continuous decrease in the total population number and an increase in the share of old people. This process does not have the same intensity in all municipalities, which leads to the fact that the Skopje region still records a slight increase in population nowadays (Bakić, Radić, 2017). At the same time, the differences in the intensity of those processes at the territorial level led to the regrouping of municipalities by their population size.

In fact, the decrease in the population number is also reflected in its distribution within the municipalities. As a result, a decrease in the average size of municipalities from 25,282 inhabitants in 2002 to 22,959 inhabitants in 2021 occurred.

In this period, there was a process of decreased number of municipalities with less population and increased concentration of the population in larger municipalities. The increase in the number of municipalities with up to 5,000 inhabitants and municipalities from 30 to 50,000 inhabitants is most pronounced. The number of municipalities with over 70,000 inhabitants decreased, and no municipality counted for more than 100,000 inhabitants in 2021.

Such population changes indicate the uneven territorial distribution of the population but also impose the question of sustainability of some municipalities. The smallest municipalities, with smaller population sizes and a not-so-favorable demographic structure, face many problems in their functioning. Low income and lack of economic development prospects in many parts of the country are key factors challenging sustainable return and have become major "push factors", for the young and highly skilled (Dimova, Wolff, 2009; Lukić et al., 2012).

Insufficient population potential limits the possibilities for sustainable development, functioning of institutions, use of resources, etc. Some of the municipalities, especially the smallest ones, are in an extremely unfavorable condition and their survival as units of local self-government is in question.

If the problems exist for decades and are just deepening rather than being solved, then approach needs to be changed. Population policy and rural exodus are complex problems that cannot be solved independently of the agricultural policy, planning construction of infrastructure, sustainable development policy and all in accordance with national policy (Babović, 2016).

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THE BEHAVIOR OF DOMESTIC TOURISTS IN PROTECTED AREAS IN THE REPUBLIC OF NORTH MACEDONIA AND ABROAD

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ABSTRACT

Protected areas are places that attract a large number of tourists. The behavior of tourists in protected areas is of great importance for their sustainable development. In every protected area, there are certain measures and conditions for how the tourist should behave when visiting, but self-awareness is also important. Based on field research and survey questioning of domestic tourists about the perception and expectations of the management, arrangement and presentation of the protected areas in the Republic of North Macedonia and the region, a comparison was made for them. This paper aims to give a clearer picture of the thoughts of a certain number of respondents, where the current state of the protected areas in the Republic of North Macedonia will be perceived concerning the protected areas in the region. From the survey-based research, the respondents will answer questions related to the arrangement and availability of the protected areas, their promotion and the included activities that take place in the protected areas, their management and of course the degree of their protection and taking measures. The main challenge in preventing the negative impact of tourist activities is inviting tourists to protect and preserve the natural environment through effective and efficient media for communication and greater engagement of the institutions responsible for protected area.

Keywords: domestic tourists, protected areas, questionnaire, Republic of North Macedonia

INTRODUCTION

Nature has always attracted people with the beauty it creates. However, for the natural potential of certain territories to be appropriately used, nature should be valorized, geo-conservation, and sustainable development. The protected areas are the ones that attract a large number of tourists. The protected area is a geographically defined area, allocated or declared by the competent authorities to be managed in terms of achieving specific goals of protection and conservation, it is a place that is subject to legal or administrative protection regime intended for the conservation and promotion of species who live in it (Official Gazette of RM, no. 84/07). According to IUCN, a protected area is: "A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley N., 2008). Protected areas possess high values and attractions that are adequately interpreted, arranged and promoted for geotourism purposes. The way they are promoted raises public awareness of their importance but also highlights the degree of danger they are exposed to.

The economic value of protected areas can be interpreted through different forms of tourism, that is, through geotourism. Geotourism is based on the values of the abiotic environment. Geotourism is a form of natural area tourism that specifically focuses on geology and landscape. It promotes tourism to geosites the conservation of geodiversity and an understanding of earth sciences through appreciation and learning. This is achieved through independent visits to geological features, use of geo-trails and viewpoints, guided tours, geoactivities and patronage of geosite visitor centers (Newsome and Dowling, 2010). Tourism offers a privileged means of raising environmental awareness among the general public. It also represents a valuable opportunity to support traditional economic activities and to improve the quality of life. To meet the needs of the protected areas as well as the expectations of visitors, it is essential that tourism preserves the environment on which its activity is based. The number of "interested people" depends of course on the activities of the protected area management, but it is also influenced by the concrete location of a protected area: Close to a big city or neighboured by a well-developed tourism destination there are "automatically" more visitors coming to the area (The PARKS & BENEFITS project, 2012). Any natural or cultural object, representing Earth sciences knowledge, which may generate tourism activity, after appropriate provision and promotion (Doktor, M. et all, 2015). The behavior of tourists in protected areas is of great importance for their sustainable development. In every protected area there are certain measures and conditions for how the tourist should behave when visiting, but self-awareness is also important. If the visitor does not comply with the given measures and rules determined by the nature protection law, he will face criminal sanctions (Official Gazette of RM, no.67/2004, 14/2006; 84/2007; 35/2010; 47/2011; 148/2011, 59/2012 and 13/2013). With the system of protected areas, valuable, representative and rare treasures of natural heritage are protected for the benefit of present and future generations. To have sustainable development in the protected areas, it is necessary to systematically manage the existing resources in a certain location, use all its potential, establish good marketing, and all this should be in line with the preservation and protection of nature. (Kolchakovski and Dimitrovska, 2009). Every country, region and area that strives for the development of geotourism simultaneously devote great care to the protection of the natural values of that area. This is for the simple reason that most tourists come to a destination precisely to enjoy and "discover" those unique attractions, which they cannot see in their region or their country. Therefore, the development of geotourism is inextricably linked to the protection and preservation of the landscape, nature and natural values. With the development of geotourism in a country, natural values are promoted, which creates an economic benefit on the one hand, and the other hand, they should be properly protected and provided with sustainable use.

The natural conditions in the Republic of North Macedonia (geological composition, relief, climate, hydrography, soils, flora and fauna) made it possible to count as one of the few countries in Europe with a wealth of natural rarities (Todorova, et all, 2019). The network of protected areas in the Republic of North Macedonia includes 82 areas with a total area of 357,778.05 hectares, which represents about 13.92% of the total territory of the country. (SSORM: Environmental statistic, 2024). Tourism is an important mover of economic development in the Republic of North Macedonia, but the potential for the development of geotourism has not yet

been fully utilized. (Todorova et all, 2018). Geotourism is one of the newest concepts in the field of tourism, which is developing rapidly and has become widespread in the last few years. More recently, domestic tourists have shown interest in visiting the protected areas in the Republic of North Macedonia, but still more interest in visiting the protected areas outside the country's borders.

The purpose of this paper is to analyze the thoughts of domestic tourists about their behavior in protected areas the perception of management in protected areas, their arrangement and their presentation in the Republic of North Macedonia and outside the country's borders. From the obtained data, a comparison of the data will be made and the thoughts and problems indicated by the domestic tourists will be seen, and based on that, appropriate measures will be proposed to raise public awareness for greater promotion, protection and conservation of the protected areas in the Republic North Macedonia and the same to be realized soon. The protection of the protected areas in the Republic of North Macedonia should be achieved through some currently most acceptable ways, such as the protection of natural rarities by setting aside zones for recreation, their treatment in spatial organization plans and their protection according to the law (Zikov and Atanasov, 1993).

OBJECTIVES AND METHODS OF THE RESEARCH

The purpose of this research is to see the thoughts of domestic tourists about their behavior in the protected areas in and outside the borders of the Republic of North Macedonia in relation to the arrangement and availability of the protected areas, their promotion and the included activities that are carried out in them, their management and certainly the degree of protection and taking measures in the protected areas. The sampling method was used as the method of this research. The sampling method is based on the examination of a relatively small number of randomly selected persons, to obtain information about the observed characteristics of the entire population.(Risteski and Trpkova-Nestorovska, 2014). For this purpose, as part of the labor needs survey, 119 respondents were randomly selected according to a predetermined anonymous questionnaire. The research was conducted in the period from 20.05.2024 to 26.05.2024 through social media. According to the gender structure in the survey, respondents from the female gender dominate (72.3%), on the contrary, the male gender is represented by (27.7%). In the course of conducting the survey, some of the protected areas in the Republic of North Macedonia and outside the country's borders were selected, which served us to obtain results on what knowledge the respondents have regarding their tourist arrangement, their accessibility, their promotion and their protection, but of course also their geotourism potential. The ability of a site to attract and receive tourists with concerns about accessibility, resource quality, interpretation of resources, and so on. The totality of natural, cultural, historical and socio-economic background for the organization of tourist activity in a particular area (Yan, L.; et all, 2017). The questionnaire is composed of 44 questions, which are adapted to respondents with different age structures, according to the topic belong to four groups, namely: visit to protected areas, knowledge about protected areas in the Republic of North Macedonia, knowledge about protected areas outside the borders of The Republic of North Macedonia and the respondents' opinions on knowledge of protected areas within and outside the borders of

the Republic of North Macedonia. The answers to the questions are statistically processed and refer to the knowledge of the relevant concepts, areas, their protection, or the thinking of the respondents on certain problems. The questions contain from 3 to 7 categories, which correspond to an evaluation from the best (excellent) to the weakest (unsatisfactory). For each question, the percentage ratio of the answers that belong to the previous grades has been calculated, and some of the questions include the text answers of the respondents.

Table 7. Part of the protected areas within and outside the border of the Republic of North Macedonia was used for the needs of the survey research

PART OF THE PROTECTED AREAS WITHIN AND OUTSIDE THE BORDER OF THE REPUBLIC OF NORTH MACEDONIA WAS USED FOR THE NEEDS OF THE SURVEY RESEARCH	
Natural Monument **"Canyon Matk**a" - - North Macedonia	**- Rila Monastery Nature Park-** Bulgaria
Natural Monument **"Vevchani Springs"** - North Macedonia	**Frushka Gora** National Park- Serbia
Natural Monument **"Kuklica"** - North Macedonia	**The Djavolja Varos (Devil's Town**) Natural Landmark- Serbia
Pelister National Park - North Macedonia	**Plitvice Lakes** National Park- Croatia
Natural Monument **"Demir Kapija Gorge"** - North Macedonia	Natural monument **Postojna Cave** - Slovenia
Mavrovo National Park - North Macedonia	**Meteora** - Greece
Natural Monument **"Smolarski Waterfalls"** - North Macedonia	**Vjetrenica Cave**- Bosna and Hercegovina
Natural Monument **"Markovi Kuli"** - North Macedonia	**Valbona Valley** National Park - Albania
the **Ezerani** Nature Park - North Macedonia	**Petralona Cave**- Greece
Galichica National Park - North Macedonia	

RESULTS AND DISCUSSION

In the first group (visits to the protected areas), three questions are included that give the general situation of how often the respondents visit the protected areas, the reason why they would visit them and whether they think that the Republic of North Macedonia has geotourism potential. According to the respondents, about 38.7% answered that they spend their free time several times a year visiting a protected area. However, about 75 respondents answered that the reason for their visit was because of the unique natural phenomena and forms that formed in the protected areas, but also to learn something new about their country and beyond. When asked if they think that the Republic of North Macedonia has a geotourism potential, a large percentage of about 86.6% answered that it has a great geotourism potential, but it is not used enough for the state to have an economic benefit that will affect all sectors of its development from it.

The second and third groups of questions refer to the protected areas inside and outside the borders of the Republic of North Macedonia. The answers to the questions from both groups will be analyzed and compared in parallel to get a result about how the respondents think about the protected areas. After all, ten protected areas from different parts of the country and nine protected areas from the region were proposed in the survey for the research, which are shown in table no. 1, all to have greater efficiency in the results. Concerning the tourist arrangement

with paths, signposts, information boards, catering facilities, souvenirs and other, of the proposed protected areas in the Republic of North Macedonia, the respondents declared that the best tourist arrangement is the Matka Canyon (113 answers or 95%), followed by Vevchanski Springs (76 or 63.9 %) and in third place is Smolarski Waterfalls (75 or 63.4%), while among the proposed protected areas outside the border of the Republic of North Macedonia, the respondents declared that Meteora in Greece is the best tourist destination (80 or 67.2%)), then Postojna Cave in Slovenia (77 or 64.7%) and NP Plitvice Lakes in Croatia (76 or 63.9%). On the other hand, from the results of the survey, it has been established that the weakest tourist arrangement in the Republic of North Macedonia has the PN Ezerani (5 answers, i.e. 4.2 %), while in second place is the Demir Kapija Gorge (14 or 11.8 %), but outside the borders of the Republic of North Macedonia as the weakest tourist arrangement, the respondents pointed out that they have NP Valbona in Albania (5 or 4.2%) and Vjetrenica Cave in Bosnia and Herzegovina (10 or 8.4%). About 92.4% of the respondents declared that they prefer to visit the protected areas in the Republic of North Macedonia on their own, i.e. independently, but on the contrary, about 73.9% of the respondents declared that to visit the protected areas outside the border of the Republic of North Macedonia, they decide to organize it with a travel agency. This comes from the fact that tourist agencies include more protected areas from the region and beyond in their offers, while an organized visit by tourist agencies to protected areas in the country is omitted or not realized at all. According to the information of the respondents on the quality of a visit to the protected area in general, the information board with all the attractions in the protected area has the most influence, then a tourist information center has been set up in the protected area itself and there are numerous brochures and informational materials. It is also of great importance if they are included in the service when visiting the protected areas and some of the new technologies such as a website with virtual tours and a visit to the protected area with the help of an audio guide (to receive information about the protected area through headphones several world languages). In addition, regarding the method of obtaining the information about the protected areas that were proposed in the survey inside and outside the border of the Republic of Macedonia, the analysis shows that of the total respondents (119), the majority (109 or 91.6 %) answered that they were most useful information received from internet sites, while in second place is information received from friends (86 or 72.3%). Regarding the accessibility of protected areas in the Republic of North Macedonia, a large percentage of the respondents, about 74.8%, stated that they are partially accessible. This means that there is no suitable path to them that will be accessible to all generations and there are not enough signposts on the roads to reach them. On the contrary, regarding the accessibility of the protected areas outside the border of the Republic of North Macedonia, the respondents stated that some protected areas are partially accessible, but a larger percentage, about 59.7%, are easily accessible to visitors. Accessibility improvements to protected natural areas should be planned in line with the goals of nature conservation and tourism development (Tverijonaite E. et all, 2018). This question is followed by the following, where the respondents gave a divided opinion, of which 38.7% said yes, and 37% said they were not sure if there is still good marking (road signs) and a landscaped path to the protected areas in the Republic of North Macedonia, while on the other hand, for the protected areas outside the border of the Republic of North Macedonia, 68.1% of

the respondents declared positively. About the tourism arrangement of the protected areas, 60.5% of the respondents stated that the protected areas in the country are partially arranged for tourism, and on the contrary, about 59.7% of the respondents answered that the protected areas in the region and beyond are well arranged for tourism.



Figure 20. The level of tourist arrangement in the protected areas.

During the very visit to a protected area, if the visitors do not behave accordingly, its degradation or destruction may occur, thereby affecting the ecosystem itself. In the questionnaire, the question "Are the visited protected areas in the Republic of North Macedonia degraded by man"? In response to this question, about 48.7% of the respondents declared that the protected areas are highly degraded. As a result, it is necessary to encourage public awareness of the need to protect the values of protected areas and appropriate behavior when visiting them. To this question, 94 respondents answered that there is insufficient public awareness of how a visitor should behave, while only nine respondents believe that some of the visitors behave appropriately in harmony with nature. Therefore, it is inevitable to note that part of the protected areas in the Republic of North Macedonia, although they are protected by law, are not given sufficient care, and this contributes to degrading (destroying) their values. To stop the anthropogenic degradation of the protected areas, it is necessary to take appropriate measures and protection. According to the total number of respondents in our country, about 68.1% believe that measures for their protection are poorly taken. Measures for their protection should be undertaken by the appropriate institutions, municipalities and non-governmental organizations, but their efforts in this direction are very weak and almost imperceptible. To encourage public awareness of the need to protect the values of protected areas and to emphasize the ways of appropriate behavior in protected areas, it is necessary to promote and present them more to the public, but also to emphasize the threats posed by visitors if they do not properly behave during their visit. In connection with the presentation of the protected areas in the Republic of North Macedonia, about 74.8% of the respondents declared that they were not adequately presented and as a result, they stated the following remarks: insufficient promotional material, insufficient promotion of domestic and foreign tourists, raising the environmental awareness

of improving the state of protected areas and more massive promotion and financial investment in them, then insufficient marketing and well-trained, professionally prepared staff, greater accessibility and the marked through mobile applications and web tools, but and there is not enough information on social networks, mostly used by the younger generations. Little attention is paid to them in teaching. Their organized visit and on-site lectures are more beneficial than a textbook lesson. Those areas are a real treasure trove of knowledge. From the school desks, the attitude of protection is built, building the awareness among the young generations of how important these areas are for us in general. On the other hand, regarding the way of presenting the protected areas outside the border of the Republic of North Macedonia, about 46.2% of the respondents stated that they are well presented through good advertisements and internet portals and that they are included in the offers of travel agencies and therefore attract a large number of visitors.

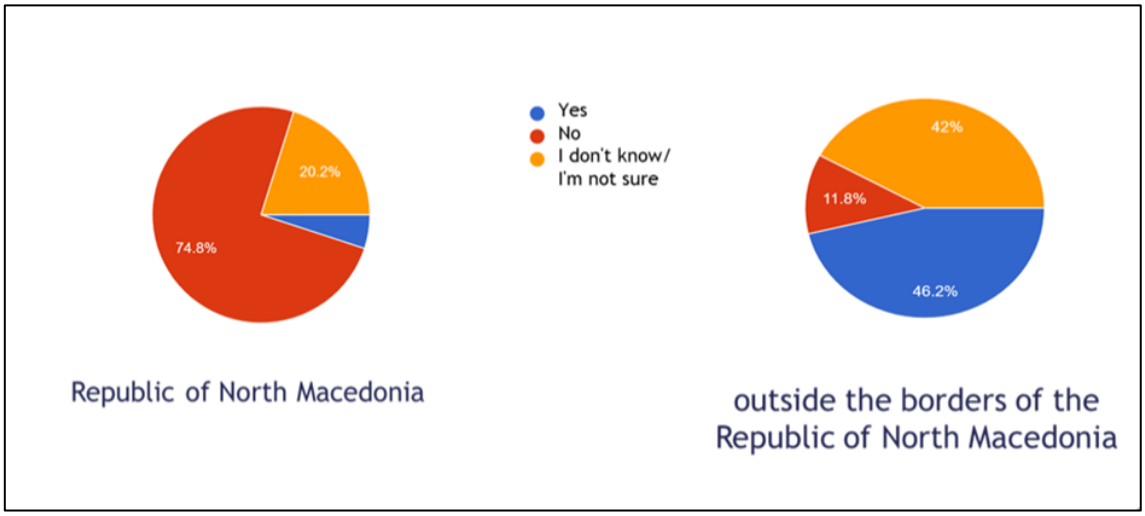

Figure 21. Adequate presentation of the protected areas

The fourth group of questions in the questionnaire refers to the respondents' opinions regarding the protected areas within and outside the borders of the Republic of North Macedonia. According to the Law on Nature Protection, when an area is declared protected, it becomes a public institution responsible for protecting and managing the protected area. For this purpose, it is necessary to have the obligation to pay the fee for entering and visiting a protected area, which is of great importance for the management of the area. Therefore, in the questionnaire, respondents asked whether they would pay an entrance fee to visit a protected area inside and outside the borders of the Republic of Macedonia, and about 79% of them answered positively. When visiting a protected area, apart from its natural beauty, visitors are also attracted to other activities or attractions that complement the entire tourist content for that area. In connection with that, the questionnaire asked the question "Are you satisfied with the tourist content and offer that is available in the protected areas within and outside the borders of the Republic of North Macedonia?" In response to this question, the respondents stated that they are not satisfied with the tourist content and offer in the protected areas in the Republic of North Macedonia and have stated several remarks in this regard, and they are: to insert more activities and animations for visitors, to add more tourist content with affordable prices, each

area has its own story, unique features, buildings, nature, anything that would serve as a basis for a tourist story and experience. This could be called branding, that is, the creation of easily absorbed content - stories that will attract attention, and the spot - content that will generate unique experiences for visitors. While, in response to the protected areas outside the borders of the Republic of North Macedonia, the respondents declared that they are satisfied with the tourist content and offer they offer. About the tourist arrangement of the protected areas specifically for the installation of tourist signposts and signs and the availability of tourist educational and informational materials (prospectus, flyers, monographs and other publications) the respondents stated the same as in the previous question. They are not satisfied with how it works in our country, but in the region and beyond, the answers are always positive. This is the result of the fact that in our country, when a protected area is arranged with nicely paved paths, installation of gazebos, information boards about the area and waste bins, they do not always remain in their original state because they are also exposed to visitors with deviant appearances. they destroy them, and with that, the whole beautiful picture of the tourist arrangement of that area is lost (Official Gazette of RM, no. 16/2019). To prevent the degradation of natural phenomena and forms, the endangerment of ecosystems and the destruction of infrastructure in the protected area, it is necessary to comply with the law on nature protection, which creates conditions for taking measures to protect nature to preserve and rationally manage certain components of biological and regional diversity, as well as sustainable and rational use of natural planning and spatial arrangement. Regarding the observance of the laws for the protection of the protected areas in the Republic of Macedonia, the respondents stated that a large percentage, about 81.5%, do not respect the laws. It is due to insufficient knowledge of the rules, measures and regulations for behavior in protected areas that are prescribed in the law on nature protection and that their non-compliance is regulated by penal provisions (Official Gazette of RM, no.67/2004, 14/2006; 84/2007; 35/2010; 47/2011; 148/2011, 59/2012 и 13/2013). On the contrary, in the answers that they stated in the survey sheet that we as visitors to the protected areas in the region and beyond respect their rules and measures of behavior, the respondents state that in most of the protected areas in the region and beyond, they have noticed employees who constantly follow the situation in them. Then they state that above all the areas are respected, they are marked, the rules of conduct are clearly written, the risky parts are properly protected and the visitors are informed about it, there is a tourist offer/guides/excursions for which information is easily found (in hotels, accommodation facilities, stands in frequented places, internet pages, etc.), are better advertised, maintained and better organization can be seen during the actual visit to these places. While it is of great importance that as visitors to the protected areas within the borders of the Republic of North Macedonia, we observe all the rules, measures and regulations of behavior in them for fear of large monetary penalties. To the question, "If we destroy part of the protected area, will we be properly sanctioned?" The answers of respondents about the destruction of a part of the protected area in the Republic of North Macedonia answered that about 62.2% think that they will not be properly sanctioned due to the non-functioning of the nature protection system, while for the protected areas in the region and beyond, the respondents answered that 69.7% think that they will be properly sanctioned for implementing the strict legal provisions.

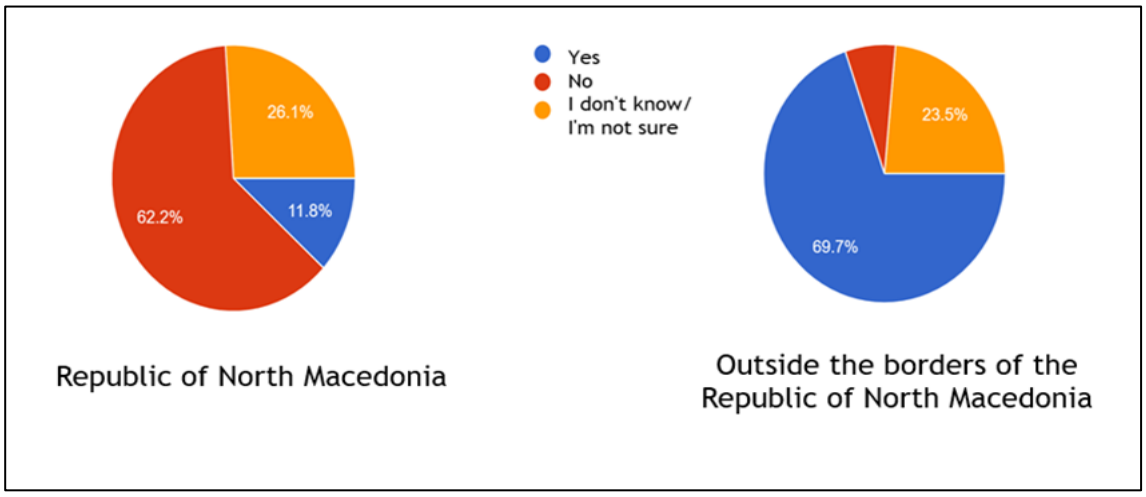

Figure 22. Will we be properly sanctioned if we destroy part of the protected area?

When analyzing the data of the respondents, it can be seen that as visitors in the protected areas in the Republic of North Macedonia, they would behave the same as in the protected areas outside the region and more broadly, primarily if the penal provisions of the nature protection law are implemented. Then if the basic infrastructure is improved, the installation of more information boards, more media coverage and installation of info-centers for visitors in the areas and the same should be maintained.

CONCLUSION

The abiotic environment can be said to have attracted people since long ago, but in the last few years, great importance has been placed on geotourism, as it has become more and more attractive. This is due to the great promotion of natural phenomena and forms in protected areas by inserting rich tourist content to attract more tourists. Compared to European countries, the Republic of North Macedonia lags far behind in the promotion of protected areas as a function of tourism. A large percentage of respondents answered that the Republic of North Macedonia has great geotourism potential, but it is not used enough for the state to have an economic benefit that will affect all sectors of its development from it. A major handicap for the promotion of protected areas is the basic infrastructure, the lack of information boards, media coverage and info-centers for visitors. Cooperation with local communities, tourist and non-governmental organizations is important for their preservation and promotion. With the development of geotourism in a country, natural values are promoted, which creates an economic benefit on the one hand, and the other hand, they should be properly protected and provided with sustainable use.

From the obtained results of the total number of respondents, it can be concluded that we appreciate and respect the protection laws in the protected areas outside the borders of the Republic of North Macedonia more than in the country itself and therefore we are careful how we behave when we visit them. To change that, appropriate measures should be taken which will be implemented by the institutions competent for that purpose, municipalities and non-governmental organizations. To implement this, it is necessary to take measures such as the introduction of educational content from the preschool age about the protected areas and how we should behave in them, then there should be media advertising about the protected areas

and how to respect the laws in them, to have more promotions and to be included in the offers of the tourist agencies in our country, to punish any offense in the protected areas and to have a greater commitment from the institutions for their management in the presence of appropriate staff and others. To prevent the degradation of natural phenomena and forms, the endangerment of ecosystems and the destruction of infrastructure in the protected area, it is necessary to comply with the law on nature protection, which creates conditions for taking measures to protect nature to preserve and rationally manage certain components of biological and regional diversity, as well as sustainable and rational use of natural planning and landscaping. The main challenge in preventing the negative impact of tourist activities is inviting tourists to protect and preserve the natural environment through effective and efficient media for communication and greater engagement of the institutions responsible for protected areas.

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SECTION TEACHING AND EDUCATION IN GEOGRAPHY

DEVELOPING STUDENTS' CRITICAL THINKING THROUGH PROJECT TASKS IN GEOGRAPHY LESSONS

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ABSTRACT

A well-developed student personality requires the acquisition of specialized knowledge, but also the development of critical thinking. There is a causal relationship between the acquisition of knowledge and the development of intellectual skills. The task of critical thinking is not the acquisition of numerous facts, but the mastery of cognitive skills. This can be achieved through student activities on a research project in a specific period of time with specific resources and organization. Project tasks allow students to develop their skills and abilities through independent research on concrete examples (model learning) and through a combination of convergent (logical) and divergent (creative) thinking. Project tasks allow the teacher to create different methodological scenarios that achieve a new quality of teaching and a higher level of student motivation. Teachers and students create an interactive, collaborative and constructive relationship in which students acquire knowledge independently based on previous experiences and their own abilities. The aim is to lead students to independent conclusions, the formation of values and the application of knowledge, which in this way becomes more permanent.

Keywords: geography lessons, critical thinking, specialist knowledge, project tasks.

INTRODUCTION

Modern teaching in the 21st century requires the acquisition and application of knowledge from different fields, which requires active participation of students, both in the acquisition of knowledge and in its application. In contrast to lectures, in which the student usually only listens passively, modern teaching places demands on the student, the solutions to which are achieved both through independent activities and in cooperation with other students or society as a whole. Geography lessons offer great opportunities to break free from the constraints of lectures. It is rich in diverse content that is thought-provoking, highly motivating and encourages students to learn actively. A modern organization of geography lessons in primary and secondary schools is inconceivable without innovations. Modernization means not only the modernization of didactic systems, but also the use of new forms and methods of work as well as new didactic materials and tools.

Our research shows that experts' knowledge does not differ semantically, but that information tends to be linked. The experiments carried out showed that the size of words and the speed at which words are retrieved from memory varies among people with different back-

ground knowledge. The results of our study could also help to give better, personalized instructions to users in different areas and support the development of a more interactive dialog between the user and an intelligent tutoring system.

According to Bognar and Matijević (2002), the development of critical thinking in students is achieved through discovery, research, experience, evaluation and creation. In geography lessons, students' critical thinking can be developed through the ability to connect phenomena, processes and laws when analyzing complex geographical systems. In creating project tasks, students can develop the ability to apply innovative activities that improve sustainability at local, regional and global levels. Students develop the ability to question their own role in the local community and global society by motivating them to continuously evaluate and carry out various activities. In this context, the paper analyzes the content of the geography project tasks recommended by the teaching and learning program in primary and secondary school. The implementation of project tasks is done by applying an interdisciplinary approach, linking the content of different subjects to apply students' knowledge in specific situations.

DEVELOPING STUDENTS' CRITICAL THINKING THROUGH THE APPLICATION OF PROJECT-BASED TEACHING IN GEOGRAPHY

The successful development of a student's comprehensive personality involves not only the continuous acquisition of knowledge, but also the development of critical thinking, which has the task of shifting the student's focus from the acquisition of knowledge and the acquisition of numerous facts to the use of cognitive processes in learning, the solution of problem situations and the application of acquired knowledge. This can be achieved through the use of project teaching based on problem solving, research, independent work of students and interaction between students and teachers with the aim of achieving knowledge and results. Project teaching is based on joint, collaborative and partnership learning, is suitable for achieving complex learning goals and promotes the development of students' research, communication, organizational and critical thinking skills (Fabijanić, 2014). The main characteristics of project-based teaching are: Focus on the student, collaborative relationship between students and teachers, addressing current real-life problems in the environment, connection with other scientific fields and human activities, collaborative teamwork, improvement of students' organizational and communication skills, introduction of new learning methods.

Some authors define the basic principles of project teaching: the focus of the lesson is on the student, who must be helped to develop their collaborative skills; each student works at their own pace and according to their abilities; the complexity of the teacher's projects contributes to a balanced development of the students' physical functions; the knowledge acquired during the implementation of the project is of a universal character and has a great transfer value (Vilotijević, Mandić, 2018). The project lesson begins with a question and an assignment. The teacher guides the students through a process of asking questions, researching literature, questioning information and using reliable information. It should be noted that the lessons will be more successful if they are more focused on solving real-world problems and using specific tools and skills, i.e. if the questions are current and important to the students. The teacher helps them to evaluate the effectiveness of each activity and, if they encounter insurmountable

problems, to offer possible solutions or strategies to help them overcome these problems. In this way, they learn to accept criticism, acquire certain knowledge, improve their work and thus achieve better results.

Project-based instruction implements activities that facilitate student learning and are carried out with little or no teacher involvement while accomplishing highly important educational goals. Since project-based lessons have different objectives than lecture-based lessons, they are divided into specific and general objectives (Munjiza, Peko, Sablić, 2006). Specific objectives are those that depend on the chosen topic of the project. The general objectives of project teaching include the acquisition of knowledge and the ability to apply this knowledge in real life, the development of the ability to cope in various situations, interest in research and an exploratory approach to learning, the development of a positive attitude towards work and work values, creative learning and the application of acquired knowledge in practical work, active relationships in any situation, the development of communication skills, environmental awareness, tolerance and respect for human rights, self-confidence, organization and self-responsibility (Munjiza, Peko, Sablić, 2006). In project lessons, all students are active, and the activities and roles of students and teachers also change considerably. In order for each student to learn and develop independently, the teacher must design and plan the activities well so that the learning process is effective. The basic task of project teaching can be described from the teacher's point of view as the development and application of the teacher's creative skills and their influence on the development of the students' creative thinking. In project teaching, the student has much more responsibility for their own learning, a more active role than in traditional forms of learning/teaching, students gain greater autonomy because they know how to learn and communicate, they learn to control their learning and working process, which is important for acquiring knowledge at a higher level and applying acquired knowledge and skills in real life.

Project teaching has the task of getting students to develop and practice higher cognitive functions (organization, synthesis, analysis and evaluation of material). It also develops important skills such as: inventiveness (creative use of knowledge sources, different methods and explanations); problem-solving skills (observing, formulating and solving, analyzing and evaluating the solution obtained); integrative skills (analyzing ideas, experiences and information from different sources and different fields); decision-making skills (deciding what is important to include in the work); the ability to manage one's own work process (the ability to carry out a more complex task independently, the ability to take the initiative); the ability to communicate effectively with others (effective collaboration and exchange with others, the ability to express one's own ideas through written texts) (Đorđević, Živković, Jovanović, 2019). New forms of knowledge acquisition (learning), which are no longer formulated as literal, mechanical, verbal and repetitive learning, are suitable for students guided by the principles of project teaching.

Project tasks with a problem character contribute to a student-centered continuation. When organizing project lessons, the degree of structuring of the task is important, which is reflected in how many options the students are given when selecting the topic and materials for creating the task. In structured tasks, the choice of topics for the work is limited and most

of the material needed to create the task is provided. In unstructured project tasks, students can choose the topic and the materials needed for the work completely independently. The third type of semi-structured assignments are those in which the research field and methodology are predetermined, but the work is such that it requires a certain degree of independence and responsibility from the student (Živković, Jovanović, Rudić, 2015). In addition to the different degrees of structuring of the tasks, the teacher must define the basic rules in order to create a working atmosphere in the team and thus ensure a positive learning environment. In the teaching process, the teacher should remove obstacles to learning, monitor the flow of work and promote the students' key skills by asking open questions and giving constructive feedback. In the application of project teaching, the teacher as a manager has several roles and he is an organizer, planner, guide, collaborator, helper, coordinator, diagnostician and evaluator (Anđelić, Kuleto, Radić, 2013). Successful planning, implementation and evaluation of the project requires that the teacher is trained in new ways of working and uses modern teaching methods to develop students' creativity and encourage teamwork.

By choosing tasks of a problem nature in achieving the results of geography lessons, the teacher is given the opportunity to create different methodological scenarios that achieve a new quality of teaching and a higher level of motivation among students. The teacher and students create an interactive, collaborative and constructive relationship in which students acquire knowledge independently based on previous experiences and their own abilities. By learning about and understanding the connections and relationships that exist in nature, students form desirable values and habits that they retain throughout their lives. They ask questions every day about the world around them and the phenomena that take place in it, and the teacher's role is to help them find answers by encouraging independence and creativity in learning.

Learning through the implementation of project tasks places students at the center of the activity, who independently investigate the selected topic through predefined phases for the implementation of the project (Obradović, 2011). There are many explanations for the project process and its theoretical foundations. What most authors agree on is the fact that concrete action is one of the important starting points of the learning process. During the project, teachers and students alike work to accomplish a very realistic task. "The basis for the project is the confrontation with the experienced reality, and during this confrontation it is necessary to find one or more solutions to a concrete, real problem and to present these solutions in the final product of the project" (Maier, D. In: Sander, W. , 2005). Korkmaz and Kaptan (2000) believe that in order to carry out project tasks, it is necessary to precisely define the phases, which include the initiative to start the project and the search for a topic that can emerge thanks to an idea from a student or teacher. The teacher can offer the students a list of defined topics so that they can choose what they want to do. A concrete work plan for the project is determined, tasks, methods and time frame are defined. During the implementation of the project, the teacher and students gather information, conduct interviews, collect materials and prepare presentations. The final phase consists of a video presentation, an exhibition, a lecture and an evaluation, during which the teacher and students jointly discuss the entire process of creating the project tasks. The results of the project and the knowledge gained are discussed. Following constructive criticism, suggestions are made for improving the preparation of future project

tasks. The mentioned phases of the project enable students to identify questions whose answers they should obtain during independent work, use appropriate materials and techniques for data collection and analysis, give explanations based on the information obtained, develop critical thinking and logical reasoning (Branković, Bošnjak, Maričić, 2011). Depending on how many participants are involved in the project, they can be personal projects or small projects in which only a few students participate. They can be class projects in which all students in a class are involved, but also projects for the whole school. The creation of projects offers students the opportunity to improve themselves in a new environment with the help of modern technology, especially in obtaining the necessary information.

PROJECT TASKS IN GEOGRAPHY LESSONS THAT INFLUENCE THE DEVELOPMENT OF STUDENTS' CRITICAL THINKING

Problem-type project tasks imply that students deal with a specific problem and help to find a solution in real-life situations. The role of problem-type project tasks in pedagogical practice is complex, but also useful in many ways, because they motivate students and teachers to additional engagement, contribute to the improvement of teaching practice, promote creativity, spread ideas about the importance of education, promote ecological habits, encourage creativity, affirm the importance of nature conservation (Turuntaš, Pavlović, 2013). The role of the geography teacher in the education system is based on the provision of quality geographical knowledge to students in regular geography lessons. The most important tasks of teachers are to find the best pedagogical solutions for different circumstances, to identify students' needs and interests, to plan and implement project activities, which should be carried out in a positive working atmosphere. In addition, the teacher must prepare students to critically select and use information, guide them to collaborate with the local community, enable them to use various research techniques, and help them to improve discussion, debating and decision-making skills. In addition to implementing the curriculum, the teacher must also be the initiator and organizer of project activities (Jovanović, Živković, 2009). The right choice of topics, project activities and practical work enables each teacher to develop the initiative among students to take an active role in the local environment.

As of the 2018/2019 school year, project teaching has been introduced in the teaching and learning program for primary school students in the first grade in the Republic of Serbia, which is implemented as part of a compulsory lesson in the weekly schedule. Project lessons are included in the total annual fund of 36 hours, they are compulsory for all students and are carried out in accordance with the instructions that are an integral part of the program for the first grade of elementary school. The instructions for the application of project teaching stipulate that the teacher defines the type of project, its aim, the expected results, the area covered by the project and the connection to the subjects, pupils' activities, the required resources and the dynamics of the work by phases. The application of project teaching does not only apply to students in the first cycle of education. In the second cycle of basic education and in the upper cycle, in the teaching and learning programs for all subjects, it is defined as an innovative form of teaching aimed at developing students' interdisciplinary skills.

When analyzing the teaching and learning program for geography in the fifth grade (Regulations on the teaching and learning plan for the fifth and sixth grades of primary school and the teaching and learning program for the fifth and sixth grades of primary school and education: 15/2018-77, 18/2018- 1, 3/2019-83, 3/2020-3, 6/2020-94, 17/2021-1, 16/2022-1, 13/2023-458, 14/2023-384, 3/2024-1) it was noted that no project assignments were proposed for the students. Teachers are recommended to stick to basic concepts, phenomena and processes when using didactic material, different methods and forms of work. One of the recommended basic skills is proper geographical observation and observation of natural objects, phenomena and processes in the local environment, which encourages students' natural curiosity, independent research and their correct interpretation. The contents of physical geography offer the possibility of acquiring knowledge, skills and habits by using statistical material systematized in tables, as well as handling different measuring instruments and registering and processing the data they display. If there is the possibility, it is suggested that students use ICT for data processing. In this way, quantitative indicators are linked and interpreted and cause-effect relationships and correlations are identified.

When it comes to the content of the sixth grade, the program defines three project tasks (Regulations on the teaching and learning plan for the fifth and sixth grades of primary education and training and the teaching and learning program for the fifth and sixth grades of primary education and training: 15/2018-77, 18/2018-1, 3/2019-83, 3/2020-3, 6/2020-94, 17/2021-1, 16/2022-1, 13/2023-458, 14/2023-384, 3 /2024-1). The first task involves creating a poster about certain demographic characteristics of the population of Serbia, Europe and the world. In pairs, students create posters on which certain demographic features (e.g. areas with high and low population density, areas or countries with population growth and decline, areas with positive and negative natural growth, areas of immigration and emigration), i.e. structural features (the most numerous peoples in the world, arrangement of languages, arrangement of world religions, arrangement of races on earth) are depicted. For certain tasks, mute maps can be used on which characteristic areas and countries can be distinguished using the color method. If the technical possibilities allow, the students can also prepare a Power Point presentation. In this way, students will be able to independently analyze and draw conclusions on certain demographic issues and problems of the modern world and Serbia by visualizing the content. The project task entitled Let's study a settlement can be realized in group work, where each group is assigned a settlement from Serbia or the world. The task of the group is to discover and explain the location of the settlement, its size, significance, functions, appearance (physionomy of the space), way of life and whether it belongs to a certain type. Students work in groups (in class or as homework), so that each group seeks answers to one question: 1st group: What are the causes of these migrations? 2. What are the consequences of these migrations in the village? 3. What are the consequences of this process in the city? 4. What are the structures of the participating population (age, sex, education, economy, etc.)? 5. What are the functions of the village, and what are the functions of the city? 6. What is the way of life in the village and in the city? By doing this task, students apply their knowledge of cause-and-effect relationships in the process of population migration from villages to cities, and thus learn about the laws of the process of urbanization and depopulation of villages. Realization of the project task Disposal

of municipal waste in the local environment can also be achieved by applying a group form of work where students with the help of teachers can show how municipal waste is disposed of in their environment, whether it is a sanitary landfill or a landfill, where it is located, who and how lives on its edge, whether it is an (ecologically) acceptable way of solving the waste problem and how it is solved correctly (on an example in Europe).

When working with seventh-grade students, it is recommended that at the beginning of the school year, the teacher directs the students to independent work, so that during the processing of a new thematic unit, the students will be given tasks to process one or more representative countries. With the help of teachers, available statistical sources, cartographic and means of information and communication technologies, students will study individual countries of the world (geographic position, borders, size, basic natural-geographical and socio-economic characteristics). By the end of the school year, all students will have regional-geographic representations of the selected countries. In this way, students will be able to see the synthetic character of regional geography in relation to the individual disciplines of general (physical and social) geography, which is characterized by the application of analytical scientific methods (Regulations on the teaching and learning program for the seventh grade of basic education and upbringing: 5/ 2019-61, 1/2020-60, 6/2020-99, 8/2020-597, 5/2021-4, 17/2021-42, 16/2022-2, 13/2023-460, 14/2023- 399).

In the eighth grade of elementary school, students study the Geography of Serbia, and the realization of a research project in the local environment implies that the student knows the methodology of research work. The student should: define the project task; collects data from various sources and in the field; processes data, displays them in textual, tabular and graphic form and draws conclusions; presents the results of research work; describes and evaluates the geographical position of the homeland; recognizes, lists and names landforms and hydrographic objects in the area of the homeland, explains the interdependence of climate, soil and the living world; investigates and determines the specificities of the natural-geographical and social-geographical features of the homeland and brings them into correlation; explains the impact of a certain population structure on the socio-economic development of the homeland; lists and describes natural resources and explains the impact of their exploitation; describes the structure of the economy and lists indicators of the development of certain economic activities; explains the needs of natural environment protection; analyzes and proposes various measures for the improvement of the homeland; applies geographical knowledge and skills when solving problem situations in everyday life; properly cites literature sources (Regulations on the teaching and learning program for the eighth grade of basic education and upbringing: 11/2019-61, 2/2020-6, 6/2020-118, 5/2021-8, 17/2021-58, 16 /2022-2, 13/2023-470, 14/2023-407).

When it comes to the first grade of high school, the Program recommended four project tasks (Regulations on the plan and program of teaching and learning for high school: 4/2020-1, 12/2020-1, 15/2020-1, 1/2021-1, 3/2021-1, 7/2021-1, 14/2023-1). The first relates to climate change in the local environment. The source of data for the aforementioned task can be a local meteorological station or the Republic Hydrometeorological Institute of Serbia. Students can graphically present the state of climate elements (climate diagram, thematic maps), compare data for each year and draw conclusions about the movement of climate elements for the last ten

years. Special attention should be paid to the frequency of occurrences of weather disasters that have occurred in the last ten years (source of data can be local newspapers, meteorological station). By comparing data on changes that have occurred in the local environment with data on a global level (data source World Meteorological Organization https://www.wmo.int/), students draw conclusions about climate changes in the local environment and their impact on everyday life. During the preparation of the project task Monitoring the change of the water level in the river during the year, students in pairs create level charts for different rivers, explain their annual changes and compare them. If there are technical possibilities (near a river that is not deep), the students with the help of the teacher can set up a water gauge themselves and monitor the water level changes every day. In this way, students will be able to independently observe and analyze changes in the local environment. The teaching topic of the biosphere is suitable for the implementation of various mini-projects in the local environment. Depending on the conditions and availability, the teaching content can be planned so that the students, through solving various problem situations and analyzing the current situation in the local environment, come to the legality in the biosphere and understand the importance it has on modern natural and social processes. Suggested topics for the project assignment: Land degradation using examples in the local environment; Let's save the local environment from pollution. The project assignment Geoheritage in Serbia and the world implies that the students, based on the offered criteria by which an object is declared a geoheritage, critically analyze examples of geoheritage in Serbia and in the world. Based on those criteria, they should evaluate an object in nature from their environment that they consider very valuable and assess whether it can be declared a geoheritage.

In the second grade of high school, it is recommended to prepare four project tasks (Regulations on the plan and program of teaching and learning for high school: 4/2020-1, 12/2020-1, 15/2020-1, 1/2021-1, 3/2021 -1, 7/2021-1, 14/2023-1). The first one refers to the selection of a representative city settlement. It is recommended to research the development of a selected urban settlement using a group form of work. Students investigate: origin, name, geographical location, physical-geographical and socio-economic characteristics, morphological structure and functions of the urban settlement. The eTwinning project task implies that on the mentioned platform students connect with their peers from other schools in Europe and make a comparative study in the field of sustainable development (eg waste management). Students should notice the similarities and differences in the practice of (un)sustainable waste management and answer the questions that are the key prerequisites and obstacles for establishing such a system at the local level. A comparative analysis of the demographic processes of the selected regions requires students to compare certain processes, present them thematically and point to the transformation of the geographical space. Together with the teacher, the students go through all the stages of work on the project assignment. As a result of the project assignment, the students make a comparative projection of the demographic development of Southern Europe and Southern Asia. I can present research results using different ICT tools. In order for the project task Comparing the geographical position of Serbia and the countries from the region to be successfully implemented, it is necessary to divide the students into several groups. Each group would do a comparative analysis of the geographical position of Serbia and the selected

country from the region, point out the advantages and disadvantages, the impact on socio-geographical processes and the international position. When preparing the assignment, the teacher should encourage students to think critically and develop their own views, by analyzing the historical-geographical position of countries, social-geographical processes and their impact on economic development, integration processes of countries and influence in regional and world frameworks, as well as by analyzing development opportunities economy and economy outside these frameworks.

Three project tasks are planned for the third grade of high school (Regulations on the plan and program of teaching and learning for high school: 4/2020-1, 12/2020-1, 15/2020-1, 1/2021-1, 3/2021-1 , 7/2021-1, 14/2023-1). By visually observing the terrain and collecting data from various written and internet sources, students should prepare a panel or a multimedia presentation about the physical and geographical characteristics of the settlement in which they live. Students can photograph, locate and map landforms, hydrographic objects and basic biogeographic areas that are present in the observed settlement. By collecting data from the nearest weather station, students will determine the basic climate characteristics. The project task Sustainable tourist destination includes students' activities related to ways of waste management in their settlement or they make a proposal for the development of a sustainable tourist destination (where the problem of waste management will be adequately solved, economic profit will be achieved and the traditional culture and folklore of a settlement or region will be nurtured). The third project task refers to the territorial organization and the role of the Serbian Orthodox Church in the diaspora. Students can implement the above project task in correlation with the contents of the History course, which refers to the migration of Serbs, Military Krajina, Serbs in Hungary, the Second World War, the Yugoslav states.

The proposed project tasks enable the functioning of all project members and the activities of students who are enabled to realize practical and research tasks. Working on project tasks additionally motivates students because it enables creative teaching, the development of friendly relations between student and student and student and teacher. The project tasks presented in the paper enable students to develop critical thinking by applying various activities. In this way, they have a greater degree of responsibility for their own learning and have a more active role than in a lecture type of teaching.

CONCLUSION

The aim of project teaching is to acquire knowledge through joint research and practical work that will be of practical use value for students in everyday life. The main features of project teaching are: focus on the student, collaborative relationship between students and teachers, dealing with current problems from real life in the environment, connection with other scientific fields and human activities, collaborative team work, improvement of students' organizational and communication skills, introduction of new learning methods . Project teaching contributes to the development of students' critical thinking and scientific outlook on the world. Project teaching provides great opportunities for correlation and integration of teaching contents of different subjects. Students show greater interest in certain teaching content,

creativity and great motivation for work. Although the positive effects of project-based geography teaching are indisputable, it also has its drawbacks. Some of them are: the time frame of the project duration, students must be trained for this type of teaching beforehand, it requires greater engagement of students, insufficient equipment of schools with material and technical means and obstacles related to the role and competence of teachers. That is why it is necessary to organize professional training that will provide teachers with the necessary knowledge and skills necessary for the role of teaching coordinator. Also, it is necessary to work on the professional training of teachers and conduct research with teachers and students on the results of the application of project-based geography teaching in practice.

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COMPARATIVE DIDACTIC AND METHODOLOGICAL ANALYSIS OF THE GEOGRAPHY PROGRAM FOR ELEMENTARY SCHOOL IN SERBIA AND NORTH MACEDONIA

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ABSTRACT

The beginning of the 21st century is characterised by a digital society in which it is no longer sufficient for an individual to be able to read, write and calculate in order to be considered educated. The development of new technologies, especially information and communication technologies, has changed people's lives dramatically. They have also had an impact on the education system. Pupils are expected to have computer and media skills, the ability to learn independently, think critically, solve problems, work in a team, be creative and take initiative. The didactic-methodical analysis of the Geography Program for elementary schools will determine the extent to which it is possible to contribute to the development of the aforementioned skills in pupils. Geography programs are designed in a special way in all countries of the world. The aim of the paper is to analyze the Geography Program for primary schools in Serbia and North Macedonia in order to observe their similarities and differences. The results of the research indicate a significant similarity in the planned learning outcomes in both countries, while deviations are observed in the order of the studied teaching topics by class..

Keywords: Geography Program, elementary school, Serbia, North Macedonia, learning outcomes

INTRODUCION

Geography is a science that deals with objects, phenomena and processes in the natural and social environment and with the laws of their interpenetration. Since it focuses on both the natural and the social environment, geography represents a link between the natural and social sciences. The main peculiarity of geography as a science is reflected in the particular way in which it studies space and its components. The study of space from a geographical perspective means that it is first broken down into natural and social components, then the objects, phenomena and processes in space are observed and explained, and finally their effects are considered at local, regional, national and global levels. By illuminating the mutual connections between the components of space, distinguishing cause-effect relationships between processes and phenomena in space and observing their mutual influences, geography penetrates into all spheres of the earth - the sphere of human life, the sphere of the natural and social environment. Thank you to all these aspects, geography offers an understandable, interesting and up-to-date view of the world and provides valuable knowledge about it. It is therefore

not surprising that geography is recognized as one of the most important subjects in the educational process in most countries of the world (Живковић, 2021).

Modern society requires a range of skills in order for individuals to function optimally. They are expected to have IT and media skills, the ability to think rationally, critically and flexibly, the willingness to face various challenges, which they can solve independently, but also as part of a team, by offering original and imaginative ideas as solutions. All of the above skills are acquired at school, particularly in geography lessons, through the use of innovative teaching methods and forms of work that give the student an active role and a central place in the educational process (Komlenović, 2003).

This paper analyzes the geography programs for elementary school in Serbia and North Macedonia. Although geography is a unique science, the way in which its contents are selected and studied within the framework of the subject of the same name in elementary school differs from country to country. Based on this assumption, a comparative methodological-didactic analysis of the geography program in elementary school in Serbia and North Macedonia will determine to what extent the programs of the two countries differ and what similarities and differences they have. During the analysis, a brief overview of the characteristics of primary school education in the two countries is first given. Then, the importance of geography in primary education in both countries will be assessed by analyzing the annual number of geography lessons by grade level, the structure of the teaching programs, the teaching topics, the teaching content and the teaching results in the teaching programs.

ANALYSIS OF THE GEOGRAPHY CURRICULUM FOR ELEMENTARY SCHOOL IN SERBIA AND NORTH MACEDONIA

Primary education is considered a fundamental right of every child. In both Serbia and North Macedonia, primary education is free and compulsory. Until the 2007/2008 school year, when the reform was implemented in North Macedonia, it was very similar in both countries. Since this school year, students in North Macedonia start elementary school at the age of six and attend it for nine years, while students in Serbia start school at the age of seven and attend it for eight years. The division of primary school into educational cycles is also not identical in the two countries. In North Macedonia, primary education takes place in three educational cycles. The first cycle comprises grades I-III, the second cycle grades IV-VI and the third cycle grades VII-IX. In Serbia, on the other hand, primary education is divided into two educational cycles (the first cycle comprises grades I-IV, the second cycle grades V-VIII).

Geography in the curricula for elementary school

Geography is a compulsory subject in the last four years of elementary school in both countries. More precisely, geography is taught in Serbia in grades V, VI, VII and VIII (during the second cycle of elementary school education), and in North Macedonia in grades VI, VII, VIII and IX (at the end of the second and throughout the third cycle of education). If we analyze the annual amount of geography taught in elementary school, we find that geography is taught for a total of 248 hours in elementary school in Serbia, while in North Macedonia it is taught for

40 hours more (table 1). In the first year of geography lessons, students in Serbia have one geography lesson per week (36 hours in total), while students in North Macedonia have twice as many lessons (2 hours per week, 72 hours in total). In the second and third years of study, the annual amount of geography lessons is the same in both countries and amounts to 72 hours each. At the end of primary school, in grade VIII, students in Serbia have 68 hours of geography lessons, while their peers in grade IX have 68 hours.

Table 1. Weekly and annual scope of geography lessons in elementary school in Serbia and North Macedonia

Serbia			**North Macedonia**		
Class	W[7]	A[8]	Class	W	A
V	1	36	VI	2	72
VI	2	72	VII	2	72
VII	2	72	VIII	2	72
VIII	2	68	IX	2	72
The total number of hours		248	The total number of hours		288

Source: https://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/viewdoc?uuid=13da23b7-5243-443a-abdd- c73e71a24ecf, (Accessed, 22.03.2024) & https://www.bro.gov.mk/wp-content/uploads/2023/05/NP-Osnovno-2023-2024.pdf (Accessed, 22.03.2024).

In addition to the difference in the annual pool of hours, the analysis of the annual geography curricula reveals further differences. First of all, there are differences in the structure of the programs themselves, then in the sequence of teaching topics by school years and in the selected outcomes.

The structure of geography curricula

The geography curricula in Serbia and North Macedonia are characterized by structural differences. The basic elements of the geography curriculum in Serbia are: the goal of the course, the class in which the program is applied, the annual teaching fund, outcomes defined at the level of the whole class according to the revised Bloom's taxonomy, teaching topics/fields, teaching content and instructions for the didactic-methodological implementation program.

Below you will find the basic elements of the curriculum for geography in North Macedonia: introduction (which lists the objective of the subject, the classes in which the subject is taught, the annual number of hours per class and the principles according to which geography is taught), teaching objectives for a particular class, specific objectives, didactic recommendations, evaluation of student performance, spatial conditions for the implementation of the teaching program, standards for teaching staff, the date on which the implementation of the teaching program began, and the signature and date of approval of the teaching program. From all of the above, it is important to explain in more detail what the specific objectives in the curriculum entail. The part of the program marked as specific objectives contains teaching topics that are covered in the same class. They are organized chronologically, contain the name of the topic, the exact number of hours allocated to the topic and the teaching content that the

[7] Weekly teaching fund.
[8] The annual teaching fund.

topics cover. For each teaching content, there is a list of objectives, concepts, teacher and student activities, teaching methods required for teaching and learning, and outcomes.

From all the above, it can be concluded that the central place in the geography curriculum in Serbia is occupied by the learning outcomes and the learning process, while in the North Macedonian curriculum the focus is first on the objectives and only then on the learning process and outcomes. Given the structure of the program, teachers in Serbia have a lot of freedom in planning and implementing teaching and learning. When creating an overall plan, they themselves determine the number of lessons per subject and the number of different types of lessons. When creating operational plans, teacher determines the results specified at class level and ensures that they form a meaningful whole. Once the lesson plans have been drawn up, lesson planning begins for each teaching. For each lesson, the teacher independently determines the objectives and outcomes, chooses the methods and form of work, plans his or her activities and the activities of the students, and the course of the lesson. In doing so, they take into account the adopted educational standards for the end of compulsory education, the educational objectives and outcomes, the teaching content, the literature, the available teaching materials, the students' abilities, their individual characteristics, their motivation and their interests. All this is done with the intention of (https://ceo.edu.rs/images/stories/obrazovni_standardi/kraj_obaveznog_obrazovanja/Predlog%20standarda.pdf, (Accessed, 22.03.2024)):

- students are trained for independent, lifelong learning,
- develop critical and specific geographical thinking,
- master orientation in space,
- successfully use a geographical map,
- successfully use and process statistical data in the form of tables, diagrams, schemes and models,
- solve problem situations,
- do project and research tasks,
- train to work in a group and in a team;

Thus, the core of geography education in Serbia is to develop students' skills, to enable them to functionally acquire geographical knowledge, connections and laws (in all areas of the Earth's mantle, in the regions of the world, at home) and to develop attitudes that correspond to the set goals.

If we compare the above with the main objective of the study of geography, which is stated in the introductory part of the Macedonian curriculum, we can conclude that both countries strive for the same values: "The study of the subject of geography aims to enable students to acquire basic knowledge about the earth, the significance and connection of natural elements and social phenomena and processes in the modern world, to develop and promote a geographical way of thinking and to develop socially effective skills in students." (https://www.bro.gov.mk/wp-content/uploads/2018/09/Nastavna_programa-Geografija-VII.pdf, (Accessed, 22.03.2024)) However, it should also be said that the goal of geography education is formally defined in the Serbian curricula as follows: "The goal of geography education

is for the student to conceptually and structurally master the natural-geographical, demographic, population, political-geographical, economic-geographical, integrative and global phenomena and processes in Serbia and the world, while cultivating the values of multiculturalism and patriotism." (https://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/viewdoc?uuid=1cd9f883-ccfe-4a73-8ccd-95bc212169e1, (Accessed, 22.03.2024))

When it comes to lesson planning in North Macedonia, teachers can use predetermined specific program objectives when creating overall and operational plans and even when preparing individual lessons. However, in the didactic recommendation it was pointed out that the programs have an orienting character and that it is necessary to adapt them to the individual characteristics of the students in order to ensure the achievement of the set goals and results.

Teaching topics, teaching content and results

In Serbia, geography is taught in the 5th grade of elementary school as part of three teaching topics/fields (https://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/viewdoc?uuid=39629e1d-f299-4641-896c-22822d565c3a, (Accessed, 22.03.2024)):

1. Man and geography
2. Space
3. The Planet Earth[9]

At the same time, geography is taught in 6th grade in North Macedonia as part of two integrated subjects: History and Society and Natural Sciences. The curriculum for geography in grade VI is shown in Table 2. History and Society is conceived as a subject that represents the synthesis of the social sciences. It deals with the subject matter of history, geography and civic education in a multidisciplinary manner. Of the 108 lessons in History and Society, 36 are devoted to geography. The 62 hours of history are followed by two geographical topics. The first is Orientation in geographical space, for which 14 hours are allocated, followed by the Geography of the Mediterranean countries for the next 22 hours. The geographical topics are followed by political education topics, which conclude the course (https://www.bro.gov.mk/wp-content/uploads/2023/06/NP-Istorija-i-opstestvo-6-odd.pdf, (Accessed, 22.03.2024)). The Natural Sciences integrate teaching content from biology, chemistry, physics and geography because, as the name suggests, they are conceived as a subject that represents the synthesis of the Natural Sciences. They include two teaching topics from geography: *Space and the Solar system and The Planet Earth and its geospheres (lithosphere, hydrosphere, atmosphere and biosphere*) (Lameva, 2019).

From all the above, it can be concluded that in the sixth grade of elementary school in North Macedonia, the subject of Geography is taught with an annual budget of 72 hours, in which four topics are covered. Of these four topics, two each are covered within the integrated subject of History and Society and Natural Sciences. Table 2 shows the teaching content covered

[9] It can be seen as a synthesis of 6 doctrinal areas: The shape of the earth and its surface structure, The movements of the earth, The internal structure and relief of the earth, The earth's atmosphere, The water on the earth, The life of plants and Animals on the earth.

in the topics of *Orientation in geographical space, Geography of the Mediterranean countries and Space and the Solar system*.

Table 2. Part of the teaching content for 6th grade in North Macedonia

Teaching topics	Number of lessons of the teaching topic	Teaching units	Integrated subject
Orientation in geographical space	14	– Earth on a globe and map – Scale – Latitude and longitude – Orientation in space – Time zone	History and Society
Geography of the Mediterranean countries	22	– Geographical location and regional overview of the Mediterranean countries – Natural and geographical features of the Mediterranean countries – Sociogeographical characteristics of the Mediterranean countries – Economic and geographical characteristics of the Mediterranean countries	History and Society
Space and the Solar system	14	– Stars and constellations – Solar system – The movements of the Earth (Earth's rotation, Earth's axis, Earth's revolution, orbit/ecliptic) – The moon and the moon (moon, moon phases, new moon, first quarter, crescent, last quarter) – Planetoids, comets and meteors (planetoids/asteroids, comets, Halley's comet, meteors, meteorites)	Natural Sciences

Source: https://www.bro.gov.mk/wp-content/uploads/2023/03/Prirodni-nauki-6-odd..pdf, (Accessed, 22.03.2024) & https://www.bro.gov.mk/wp-content/uploads/2023/06/NP-Istorija-i-opstestvo-6-odd.pdf, (Accessed, 22.03.2024).

The selection of topics covered in geography lessons in Grade 5 in Serbia differs to some extent from the topics covered in Grade 6 in North Macedonia. For example, of the three topics covered in Grade V in Serbia, the topics of Space and Planet Earth coincide with the content of the topics of Space and the Solar System and Planet Earth and its geospheres in North Macedonia. In North Macedonia, the teaching content of the topic of humans and Geography is not covered at all in elementary school geography lessons.

As far as the teaching topic of Geography of the Mediterranean countries is concerned, there is no topic in the Serbian geography curricula that would correspond to it. As far as the subject of Orientation in geographical space is concerned, there is a corresponding subject that is studied in Serbia, Geographical map. However, it should be emphasized that the content of the subjects Orientation in geographical space and Geographical map do not completely coincide and that Geographical map in Serbia is taught only in the next, sixth grade.

In the second year of geography lessons, i.e. in the 6th grade in Serbia and in the 7th grade in North Macedonia, completely different geographical topics are covered. The 6th grade geography curriculum in Serbia aims to introduce students to the social component of geography and to gradually introduce them to regional geography.

Table 3. Curriculum of geography for 7th grade VII in North Macedonia

Teaching topics	Teaching units
Natural and geographical characteristics of the Republic of North Macedonia	– Geographical position, border and area – Mountains of North Macedonia – Basins and valleys of North Macedonia – Relief types in North Macedonia – Climatic factors and meteorological elements and phenomena – Climatic types – Groundwater and springs – Rivers and river basins – Lakes – The plant world – Animal world
Population and settlements in North Macedonia	– Basic demographic characteristics of North Macedonia – Structural characteristics of the population of North Macedonia – Migration and the population of North Macedonia – Rural settlements – Urban settlements – Territorial division of North Macedonia
Economic and geographical characteristics of North Macedonia	– Historical development of the economy in North Macedonia – Factors of economic development and economic branches – Farming – Fruit growing and viticulture – Animal husbandry – Forestry, hunting and fishing – Energy sources and mineral wealth – Industry – Craft and construction – Traffic – Tourism and trade
Environmental protection in North Macedonia	– Natural and anthropogenic environmental elements – Protection of air from pollution – Protection of water from pollution – Soil protection from degradation – Protection of flora and fauna – Protection and self-protection from natural and anthropogenic disasters

Source: https://www.bro.gov.mk/wp-content/uploads/2018/09/Nastavna_programa-Geografija-VII.pdf, (Accessed, 22.03.2024).

Accordingly, the following topics are taught (https://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/viewdoc?uuid=39629e1d-f299-4641-896c-22822d565c3a, (Accessed, 22.03.2024)): 1. Society and geography; 2. Geographical map; 3. Population; 4. Settlements; 5. Economy; 6. State and integration processes; 7. Geography of Europe.

At the same time, 7th grade students in North Macedonia learn topics from their native geography in geography classes (table 3).

The choice of teaching topics in geography is largely influenced by the learning approach. In North Macedonia, students are first introduced to general and physical geography, after which they move on to studying their local environment which is familiar to them. This approach follows the principle of learning from near to far, from local to global, or from the known to the unknown.

Further analysis of the geography curricula in both countries found that the subjects Society and Geography, Geographical Map, Population, Settlements, Economy, State, and integration processes, which are covered in the 6th grade in Serbia, are not covered at all in geography classes in the third grade. educational cycle in North Macedonia, has already been covered in the first educational cycle in the history and society classes. Given that the mentioned contents are taught at a lower age in North Macedonia and the outcomes that are foreseen for them are less demanding than the outcomes defined in the Serbian program. At the end of the 6th grade in Serbia, the teaching topic Geography of Europe is studied. It follows that students in Serbia are introduced to regional geography a year later than their peers in North Macedonia, who were introduced to regional geography during the previous grade through the topic Geography of Mediterranean countries.

In Serbia, students are introduced to the natural and social aspects of Europe in the final year of primary school. Geography lessons cover topics such as Geographical Regions and Regional Geography, Location and Borders of Europe, Natural Characteristics of Europe, Population of Europe, Settlements of Europe, Economy of Europe, and Geographical Regions of Europe. In the following year, students delve further into the regions of Europe with a dedicated unit on Geographical Regions of Europe. This unit comprises various teaching modules that provide a more detailed understanding of the continent's diverse regions:

1. Southern Europe is renowned for its rich cultural and historical heritage, ethnic diversity, tourism, as well as political differences;
2. The countries that make up Southern Europe include Italy, Spain, Greece, and the former countries of the Socialist Federal Republic of Yugoslavia. These countries share basic geographical features;
3. Central Europe is recognized for its cultural and historical heritage, modern demographic trends, natural resources, economic growth, urbanization, and political differences;
4. Germany is situated in Central Europe and shares basic geographical features.
5. Western Europe is celebrated for its cultural and historical heritage, modern demographic trends, natural resources, economic growth, urbanization, and political differences;
6. France and the United Kingdom are situated in Western Europe and share basic geographical characteristics;
7. Northern Europe - natural resources and economic development, peoples, political division;
8. Norway - basic geographical features;

9. Eastern Europe - cultural-civilization heritage, ethnic heterogeneity, natural resources and economic development, political division;
10. Russian Federation - basic geographical features;
11. The European Union - an example of integration processes.

In North Macedonia, students delve deeper into the study of Europe compared to their counterparts in Serbia. The curriculum in North Macedonia includes a comprehensive study of Europe throughout VIII grade, which aligns with VII grade in Serbia (table 4). In addition, North Macedonian students gain insight into the geography of Mediterranean countries during 5th grade, which focuses on the southern European nations. Consequently, the study of Europe's regions and countries is far more extensive in North Macedonia than in Serbia. The geography curriculum in North Macedonia places great emphasis on the study of Europe, evident from the ample time allocated to the subject (22 hours in grade V and 72 hours in grade VII), as well as the significantly higher number of learning objectives. Geography teaching content outcomes pertaining to Europe show remarkable similarities between North Macedonia and Serbia. Despite differences in the structure of their geography teaching programs, North Macedonia's outcomes may appear more extensive, as they are listed individually for each content. However, a closer examination of both programs reveals that the outcomes in North Macedonia align perfectly with the outcomes represented in Serbia's programs.

By comparing the curricula of both countries, it can be concluded that in North Macedonia, all the countries of the Balkan Peninsula, and not only the republics of the former SFRY, are studied as part of the topic Geographical overview of the region of Southern Europe. The entire Apennine peninsula is studied, not just Italy. From the Iberian Peninsula, in addition to Spain, there are also Portugal and Andorra. Within the topic of Geographical characteristics of Western Europe, students in North Macedonia, unlike students in Serbia, study all the countries of the region, not just the United Kingdom and France. Within Northern Europe, along with Norway, in North Macedonia, the remaining countries of the region are studied through two more teaching units: Sweden, Norway, and Finland, Denmark and Iceland. When it comes to Central Europe, Germany is taught as the only representative country in Serbia, while in North Macedonia, Poland, the Czech Republic and Slovakia, Switzerland and Austria, Hungary, and Romania are taught in six teaching units along with Germany. The region of Eastern Europe is studied more extensively, because in addition to Russia, which is the only country in this region studied in Serbia, Ukraine, Belarus and Moldova, Lithuania, Latvia and Estonia are also studied through four teaching units. Also, it should be noted that in North Macedonia the European Union is not studied as a separate teaching unit, as is the case with the Serbia.

In Serbia, geography students in the 7th grade receive a comprehensive education on the various regions of Europe, as well as continents like: 1. Asia; 2. Africa; 3. North America; 4. South America; 5. Australia, and Oceania, along with the Polar regions. Conversely, in North Macedonia, students are introduced to other continents only in the 9th grade, which happens to be the final year of primary school. The course material covers topics such as: 1. Asia; 2. Africa; 3. America; 4. Australia with Oceania, and the Polar regions.

Although the years of study differ, the teaching topics and contents in North Macedonia and Serbia are quite similar. Nonetheless, there are some distinctions between the two countries. In North Macedonia, the geography program allocates a specific number of hours for each teaching topic, with 21 hours for Asia, 19 hours for Africa, 21 hours for America, 11 hours for Austria, and a combined 8 hours for Oceania and the polar regions. The teacher is responsible for determining the exact amount of time to be spent on processing, determining, systematizing, and checking knowledge from the given hours. On the other hand, in Serbia, teachers have more flexibility in determining the number of lessons for each topic, as well as the number of lessons by type, independently.

Table 4. Curriculum of geography in VIII grade in North Macedonia

Teaching topics	Teaching units
Natural and geographical characteristics of Europe	– Geographical location, borders, and size of Europe – Erosion of the European coast – Topographical features of Europe – The impact of climate on the various climates of Europe – Vegetation zones based on climate in the temperate region of Europe – Vegetation zones based on climate in the polar region of Europe – Major rivers and their basins in Europe – Lakes situated in Europe
Socio-economic characteristics and regional division of Europe	– Basic characteristics of the population of Europe – Linguistic characteristics, religious affiliation and diversity of the population of Europe – Culture, traditions and customs of the European population – Settlements in Europe – Regional and political-territorial division of Europe
Geographical overview of the Southern Europe region	– Geographical characteristics of Southern Europe – Bulgaria – Greece – Serbia – Albania – Croatia and Slovenia – Montenegro and Bosnia and Herzegovina – Italy, San Marino and the Vatican – Spain, Portugal and Andorra – Endangerment, pollution and environmental protection of Southern Europe
Geographical overview of the Western Europe region	– Great Britain and the Republic of Ireland – France – Benelux (Belgium, Netherlands, Luxembourg)
Geographical overview of the regions of Northern Europe	– Sweden – Norway and Finland – Denmark and Iceland
Geographical overview of the regions of Central Europe	– Germany – Poland – Czech Republic and Slovakia – Switzerland and Austria – Hungary – Romania
Geographical overview of the regions of Eastern Europe	– Russia – Ukraine – Belarus and Moldova – Latvia, Lithuania and Estonia

Source:https://www.bro.gov.mk/wp-content/uploads/2018/09/Nastavna_programa GeografijaVIII.pdf, (Accessed, 22.03.2024).

After analyzing the curriculum for various geographical topics, it can be concluded that both countries cover the natural, social, and economic aspects of the continent. However, there are differences in the way regions are studied. For example, in the case of Asia, Serbia approaches it by region, whereas North Macedonia only covers China as an economic powerhouse and India as a blend of languages, cultures, and traditions. As for Africa, Serbia divides it into Mediterranean and Saharan Africa and Sub-Saharan Africa, while North Macedonia breaks it down into North, Central, West, East, and South Africa, and South Africa as a country of contrasts. The geography program in North Macedonia covers North and South America separately, with the USA as a world superpower and Brazil as an agricultural giant of the south taught as distinct units. In Serbia, the political divisions of both continents are studied. Australia, Oceania, and the polar regions are taught similarly in both countries.

Due to the factors mentioned above, it is anticipated that the expected results in both countries will be quite similar. However, there are some differences. In Serbia, the outcomes outlined in the curriculum are meant for the whole class, so they are generally broad and applicable to all continents. Some of the outcomes include:

- defines the boundaries of the continent and shows on the map the oceans and seas that surround the studied continent and locates the largest islands, peninsulas, straits, isthmuses, passages, capes;
- finds the studied regions on the state map and names them;
- shows on the silent map: continents, oceans, seas, forms of coastlines, plains, mountains, rivers, lakes, states, cities;
- classifies landforms, water bodies and living world characteristic for the specified territory;
- analyzes the influence of latitude, relief, the relationship between land and sea, sea currents, vegetation and man on the climate;
- finds data on the numerical state of the population by county, region and selected countries and singles out spatial units with the highest concentration of population in the world;
- describes the causes and consequences of urbanization on different continents, regions and in selected countries;
- links natural resources with the degree of economic development of certain regions and selected countries;
- explain the formation of the political map of the world;
- explains the causes and consequences of global phenomena such as poverty, internal and external migration, demographic explosion and overpopulation, diseases and epidemics, political instability;
- link the quality of life of the population with the natural, demographic, economic and political-geographic features of the area;
- describes the role of international organizations in the world.

When comparing the 9th-grade geography programs in North Macedonia and Serbia, it becomes clear that while each program has specific outcomes for their teaching content, there is significant overlap between the two. For example, the outcome in the Serbia curriculum that requires students to explain the causes and consequences of various global phenomena, such as poverty, migration, epidemics, and political instability, aligns with multiple specific outcomes in the North Macedonia program. The North Macedonia program's teaching units, "South Africa - Country of Contrasts," and "Lack of Food and Water: The Most Serious Problem of the African Population" have outcomes that align perfectly with his needs. The results of these two units are precisely what he requires. (https://www.bro.gov.mk/wp-content/uploads/2018/09/Nastavna_programa-Geografija-IX.pdf, (Accessed, 22.03.2024)):

- the student knows the positive and negative sides of South Africa (apartheid, colonial past, economic development, etc.);
- critically thinks about similar phenomena in other parts of Africa and the world;
- detects problems in South Africa;
- identifies the main existential problems of the African population and explains them using geographical thinking
- explains the great inequality between the African population and the rest of the world.

It can be observed that the eighth-grade geography programs of Serbia and the seventh-grade programs of North Macedonia share similar curricular objectives. In line with many Balkan countries, the study of local geography is typically taught in the culminating year of primary school in Serbia (Dermendzhiev and Draganova, 2017). Irrespective of the discipline, the methodology for exploring the topography of one's own nation is remarkably alike in both nations. Table 5, appended herewith for your perusal, presents a comparative synopsis of the subjects linked to the indigenous geography of the two nations, as proof thereof.

Table 5. List of the topics covered in the teaching programs of native geography in Serbia and North Macedonia

Serbia	**North Macedonia**
Teaching topic	*Teaching uit*
Geographical position, borders and size of Serbia	Physical and geographical characteristics of North Macedonia
Physical and geographical characteristics of Serbia	Population and settlements in North Macedonia
Social and geographical features of Serbia	Economic and geographical characteristics of North Macedonia
Natural and cultural heritage of Serbia	Environmental protection in North Macedonia
Geography of the homeland	/
Serbs in the region and the diaspora	/

Source: https://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/viewdoc?uuid=7f60db16-8760-4e25-bc8a- f69fe1fb2e2c, (Accessed, 22.03.2024).

According to Table 5, it is evident that Serbia offers six teaching topics for native geography, while North Macedonia provides four. Although the teaching content is quite alike, North Macedonian students do not have a specific topic that focuses on their diaspora. Therefore, this

particular learning outcome is missing in the Macedonian curriculum. Nonetheless, both programs share a similar structure. It's important to note that the amount of time dedicated to studying native geography can differ between countries. For instance, in Serbia, teachers have 68 hours allocated to studying native geography, whereas in North Macedonia, they have 72 hours to study their geographical homeland.

CONCLUSION

Geography holds a vital place in the primary education systems of Serbia and North Macedonia, but the two countries differ in their approaches to teaching it. Primary education in Serbia spans eight years, from the age of 7 to 15, whereas in North Macedonia it lasts for nine years, from the age of 6 to 15. However, both countries mandate that geography be studied as a separate subject during the final four years of primary education. In Serbia, this takes place during grades V, VI, VII, and VIII, while in North Macedonia, it is during grades VI, VII, VIII, and IX. The annual fund of geography lessons is not the same in both countries. Namely, in North Macedonia geography is studied in primary schools for 288 hours, while in Serbia 40 hours less are devoted to it.

Based on a comprehensive analysis of the geography program, it was discovered that in North Macedonia, geography is taught as part of two integrated subjects - History and Society, as well as Natural Sciences - during the first year of study. The purpose of this approach is to effectively showcase the interrelation between social and natural sciences through appropriate teaching methods. As geography serves as a bridge between these two fields, it is an excellent subject for this purpose. However, this approach has yet to be implemented in primary education in Serbia.

After conducting an analysis of the structural components of geography programs in two nations, it was discovered that there are notable similarities and differences. Although the primary aim of the subject is defined similarly in both countries, the presentation of objectives and outcomes by grade level varies. In North Macedonia's programs, the goals are of utmost importance, whereas in Serbia, the learning outcomes and processes are given more emphasis. In North Macedonia's academic programs, each class and subject has specific goals outlined, in addition to overall subject goals. In contrast, Serbian curricula only provide a general goal for each subject. Outcomes are presented in a general manner for the class, with teachers responsible for specifying them when creating operational plans and preparing individual lessons. North Macedonia's educational programs provide detailed learning outcomes for each specific teaching content, rather than a general outcome for the entire class. As a result, the number of outcomes may appear higher than those in Serbia. However, upon closer examination, it becomes clear that the increased specificity of North Macedonia's outcomes typically aligns with only one class outcome in Serbia's program. Therefore, the learning outcomes for the same teaching contents in both countries are essentially the same.

Upon analyzing teaching topics, it has been discovered that the sequence of study varies between North Macedonia and other countries. In North Macedonia, pupils are initially taught general, physical, and partly regional geography during their sixth grade. The following year, during the seventh grade, they begin to delve into the geography of their homeland. Given that

North Macedonia is situated in Europe, this continent is thoroughly studied throughout the eighth grade. The other continents, which may be completely unfamiliar to the students, are only explored during the final year of primary education. The teaching curriculum was thoughtfully designed to follow a logical sequence, with a focus on learning from the familiar to the unfamiliar. This means that students began with topics related to their local environment and gradually progressed towards more obscure and foreign regions of the world. Conversely, in Serbia, a different approach is taken, with topics being arranged from distant to closer regions. For example, in the 6th grade, students learn about Europe, followed by its various regions and other continents in the 7th grade. Finally, in the 8th grade, which marks the end of primary education, the focus shifts to the homeland of Serbia.

Although there are some differences in the order of teaching topics between the two countries, the study content provided is quite similar. However, it is worth noting that Macedonian geography programs delve deeper into the study of Europe and dedicate a greater number of lessons to it than Serbia. In Macedonian programs, nearly all European countries are examined, and during the first year of studying geography, the subject of Geography of the Mediterranean countries is covered, which is not taught in Serbian geography programs. Conversely, Serbian programs place more emphasis on the teaching of physical, social, and regional geography during the first and second years of study, and this is covered in much greater detail than in primary schools in North Macedonia.

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