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Volcanic Eruptions in South Europe and the Change of Carbon Dioxide Concentration – Case Study: "Moussala" Basic Environmental Observatory

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Abstract

The volcanic eruptions are one of the most characteristic natural sources of CO₂ in the atmosphere (IPCC, 1990, 2007). In order to study the effect of volcanic eruptions on the increased levels of CO₂, we have used data from the Basic Environmental Observatory (BEO) "Moussala", Bulgaria, for the period comprised between July 2007 and March 2015. The Carbon dioxide is not a health hazard gas and there is no established limit concentration by the Bulgarian and international law. In this study, we have accepted as extremely high values the values that exceed the 95th percentile of the distribution of the daily average values for the studied period. The days with exceeding CO₂ concentration were analysed in terms of volcanic activity (Etna), which could affect the investigated area with the spread of air pollutants and also CO₂. The simulations developed by the Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) Model are used in order to describe the trajectory and dispersion of pollutant and products from eruptions of Etna in the atmosphere. A synchrony between the occurrence of days with extreme high concentration of CO₂ in the atmosphere in the region of BEO "Moussala" and eruptions of Etna volcano was established in most of the investigated cases.

The analysis of the results from BEO "Moussala" confirms the impact of the volcanic eruptions and Etna volcano, in particular, for the increasing of CO₂ concentration in the atmosphere. On the other side, it was established that the activity of Etna is not the only factor which has impact on the concentration of CO₂. More detailed analyses concerning not only natural, but also anthropogenic factors have to be done in the future in order to clarify the reasons for the increasing concentration of CO₂ in the atmosphere (IPCC, 2014).

Keywords: carbon dioxide, Etna volcanic eruptions, Bulgaria, HYSPLIT Model

Erupțiile vulcanice din Europa și modificarea concentrației de dioxid de carbon din atmosferă. Studiu de caz: Observatoriul de Mediu Moussala

Rezumat. Erupțiile vulcanice reprezintă una din sursele principale de CO₂ din atmosferă (IPCC, 1990, 2007). Pentru a studia efectul erupțiilor vulcanice asupra nivelurilor crescute de CO₂, s-au utilizat datele de la observatorul de Mediu Moussala (BEO) din Bulgaria pentru perioada cuprinsă între iulie 2007 și martie 2015. Întrucât dioxidul de carbon nu este considerat un gaz cu risc pentru sănătate, nu este stipulată nicio limită pentru concentrația acestui gaz în legislația bulgărească sau internațională. Pentru acest studiu, am considerat ca valori foarte mari cele care depășeau cu 95% valorile medii zilnice pentru perioada studiată. Zilele în care s-au înregistrat depășiri ale concentrației de CO₂ au fost analizate din perspectiva activității vulcanice (Etna), care ar fi putut afecta aria luată în analiză datorită răspândirii poluanților aerieni, inclusiv a CO₂. Simulările elaborate cu ajutorul Modelului Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) sunt folosite pentru a descrie traiectoria și dispersia poluanților și particulelor expulzate de vulcanul Etna în atmosferă. În majoritatea cazurilor, s-a stabilit o sincronizare între zilele în care s-au înregistrat concentrații extrem de mari de CO₂ în atmosfera din apropierea BEO Moussala și erupțiile vulcanului Etna.

Analiza rezultatelor de la BEO Moussala confirmă impactul erupțiilor vulcanice în general și al vulcanului Etna în particular asupra concentrației de CO₂ din atmosferă. Pe de altă parte, s-a stabilit că activitatea vulcanului Etna nu este singurul factor cu impact asupra concentrației de CO₂. Pe viitor, trebuie întreprinse analize detaliate privind nu numai sursele naturale de CO₂, dar și cele antropice pentru a putea clarifica motivele pentru creșterea concentrației de CO₂ din atmosferă (IPCC, 2014).

Cuvinte-cheie: dioxid de carbon, erupțiile vulcanului Etna, Bulgaria, modelul HYSPLIT

Introduction

Natural sources of CO₂ are mainly volcanic eruptions and large forest fires. Volcanic activity can inject large quantities of gases and aerosols into the atmosphere both during and between eruption breaks (Pareschi et al., 1999). Depending on the power of the eruption and the speed of the wind, the ejected CO₂ in the atmosphere can be transported over long distances. That is why several gases, CO₂ included, could be registered thousands of kilometers from the volcano itself.

The gases exuded in volcanic eruptions from magma at a certain depth, as well as during the cooling of lava in the lava flow, form gaseous clouds. Their composition is predominantly of sulfur compounds, carbon dioxide, nitrogen, hydrogen, methane, chlorine and compounds of boron and argon, water vapor. The greatest amount of CO₂ is contained in the gases which have a temperature below 100°C. These are the so called mofette. Volcanic ash that is released during eruptions contains lava particles, mica, volcanic glass, gases and water vapor (Kanev, 1983). Etna is one of the largest contributors of magmatic gases, CO₂

included (Allard et al., 1991; Francis et al., 1998; Williams et al., 1992). Etna is an active stratovolcano, as the cone of the volcano is formed by alternating eruptions in which lava masses alternate with tuffs (Kanev, 1983). Its height is variable, i.e. amended by volcanic eruptions. Currently, the altitude of Etna is 3330 m. a.s.l. which makes it the highest active volcano in Europe. It covers an area of 1,190 sq km in Eastern Sicily, between the African and Eurasian continental plates. The volcano is one of the most active in the world and it is almost constantly in a state of activity (Global Volcanism Program, 2013).

The high mountain station BEO Moussala is located in Rila National Park at an altitude of 2,925 m a.s.l. and it is far from major industrial pollutants and other human activities (Angelov et al., 2013). Therefore, human influence is limited to a minimum. Periodic increases in CO₂ concentration are mainly due to natural sources such as volcanoes and summer forest fires. Depending on the wind speed and its direction, increased levels of CO₂ in some cases may also be registered due to human activity, especially ventilated emissions from the activity of central heating. Because of the lack of data about more significant human activity, this aspect has not been examined in this study.

Methodology

Through comprehensive research approach and application of mathematical, statistical and analytical methods, monthly and seasonal concentrations of CO₂ in the air and meteorological parameters are calculated and trends in chronological changes are analyzed. The causal relationships between the changes in the concentration of CO₂ in the air and the natural factors (weather parameters and volcanic activity) have been established.

Tracking the movement of volcanic ash and gases which are ejected into the atmosphere from Etna volcano was done through simulations of the course of volcanic ash made by NOAA HYSPLIT model (http://www.arl.noaa.gov/HYSPLIT_info.php, accessed 30 November, 2013). This model is a system for tracking the trajectories of different air pollutants, including CO₂. In addition to determining the trajectory, the model is used in various simulations representing the deposition of pollutants on the ground. HYSPLIT model could be used also for tracking and forecasting of radioactive elements, gases from forest fires, dust and volcanic ash. For the purposes of this study, the transport of volcanic ash from Etna is used, because the greatest synchronicity was established between the occurrences of days with extremely high CO₂ concentrations in the air and moments of eruption of the volcano.

The HYSPLIT model is managed interactive online and enables tracking the emitted volcanic ash at a given period of time. The date of the volcanic eruption has to be used as input data for the simulation. The initial information about the eruptions of the volcano was obtained from the Volcano Discovery database (<http://www.volcanodiscovery.com>, accessed 30 November, 2013), where the daily state of active volcanoes on the planet is published. A period of 28 days (December 17, 2013 - January 13, 2014) is used in the present study in order to analyze the impact of volcanic eruptions on the concentration of CO₂ in the air. The choice of this period is determined by the greatest number of days (18 days) with increased concentration of CO₂ in the atmosphere, according to the data from BEO "Moussala".

Results

Chronological changes and seasonal course in CO₂ concentrations in the air

The data for monthly values of CO₂ from BEO "Moussala" were used for the analysis of annual and seasonal distribution of this indicator during the period comprised between July 2007 and March 2015. The seasonal values are defined as the average of monthly concentrations, as follows: for winter - December, January and February; for spring - March, April and May; for summer - June, July and August; for autumn - September, October and November.

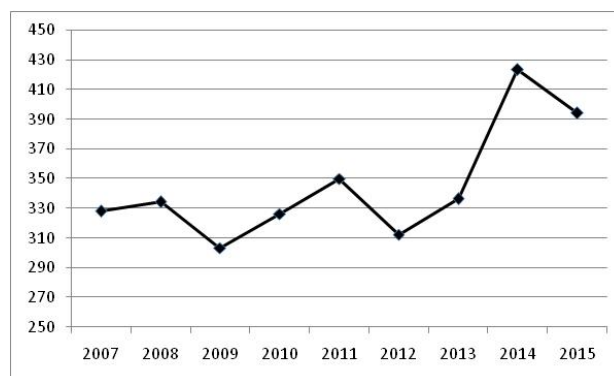


Fig. 1: Average annual CO₂ concentrations in the air (in ppm)

The highest annual concentration of CO₂ in the air is established in 2014 - 423.37 ppm (Fig. 1). The year 2014 is one of the years with the highest volcanic activity in the world and this led us to the hypothesis that the increased concentration of CO₂ in the air at the BEO "Moussala" is due to the volcanic activity.

The analysis of the average seasonal concentrations of CO₂ in the air for the period 2007-

2015 shows a clear seasonality in the course - the highest concentrations of CO₂ measured in BEO "Moussala" are registered during summer (360.81 ppm) and the lowest are registered during autumn (315.77 ppm) and winter (332.1 ppm) (Fig. 2).

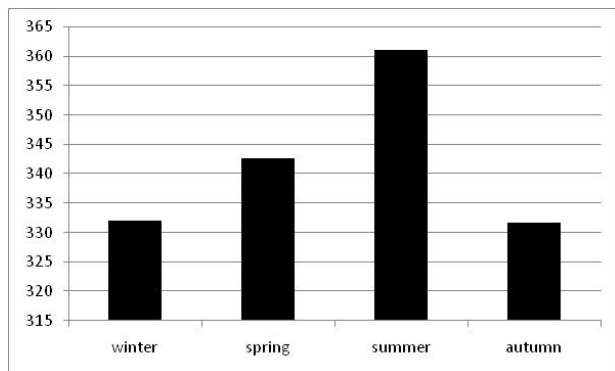


Fig. 2: Seasonal distribution of CO₂ concentration in the air (in ppm) at BEO Moussala (2007-2015)

As for the cold season in the region of Moussala peak, a relatively small amount of precipitation, few days with fog, reducing the air temperature and increasing of vertical stability of the atmosphere are characteristic and this could have caused the reduction of CO₂ concentrations for this period.

Seasonal distribution of CO₂ concentrations measured at BEO "Moussala" refers mainly to the natural factors, such as the impact and regime of the main climatic elements - air temperature, humidity, atmospheric pressure, speed and direction of the wind, as well as volcanic eruptions in the Southern European region.

CO₂ concentration in the air in the region of BEO "Moussala" and its relation to the eruption of Etna volcano

In order to show the relation between volcanic eruption and CO₂ concentrations, the data during the period comprised between December 17, 2013 and January 13, 2014 is used for the purposes of this study. This period is characterized by intensification of Etna volcano activity. The analysis of the daily concentrations of CO₂ shows that during 18 days of this period, the daily concentration of CO₂ was above 95 percentiles of the empirical distribution for each month, for the investigated period (Table 1). These days were accepted as days with extremely high CO₂ concentration.

The correlation between the increased CO₂ concentrations in the air and the activity of Etna volcano was investigated in connection with data about direction and speed of the wind measured at BEO "Moussala" (Table 2). The extreme high values of CO₂ concentration exceeded 500 ppm, but this is below the safety thresholds recommended for

human health (Granieri et al, 2014; Aerias, 2005). The most typical examples are described below.

Table 1: Days with extreme CO₂ concentrations

Year	Months	Days
2013	December	17, 19, 20, 21, 22, 27, 29, 30, 31
2014	January	1, 3, 4, 6, 8, 9, 10, 11, 13

According to the Volcano Discovery database for December 2013, the first releases of volcanic ash in the atmosphere from the northeast part of the volcano were registered on December 17, 2013. The track of the volcanic cloud, followed by HYSPLIT model, shows that it is very likely to exist a relation between the activation of Etna volcano and the increasing values of CO₂ concentration. The data from Volcano Discovery show an increasing volcanic ash in the atmosphere on December 22, 2013. The prevailing winds are west-northwest and their speed is over 2 m/s. The cloud of volcanic ash is observed in the Western part of the Bulgarian territory. The results obtained from the model showed a cloud of volcanic ash in West of Bulgaria. On December 23, 2013, a release of volcanic ash and gases with considerable power is observed in the atmosphere. The prevailing wind direction is southwest (Table 2). The HYSPLIT model shows that on the same date, the cloud of volcanic ash completely covers the airspace of Bulgaria (Fig. 3).

During the next few days, the state of Etna volcano varies from calm to quite active. The CO₂ concentrations in the air measured at BEO "Moussala" kept high levels and reached extreme or close to extreme values (Table 2).

On December 29, 2013, a loud explosion in the southeast part of Etna volcano is reported and an ejection of large amounts of volcanic ash and gases in the atmosphere is observed. Daily average concentration of CO₂ measured in the atmosphere at the region of "BEO Moussala" rose to 497.15 ppm which is above 95 percentiles of the data for December. Prevailing winds are southeast and an average speed of over 4 m/s (Table 2). The model results show cloud of volcanic ash in the airspace of Bulgaria was moving from southeast (Fig. 4).

An ejection of lava, volcanic ash and gases from the southeastern part of Etna volcano continues on December 30, 2013 (Volcano Discovery). The resulting models clearly show covering of all airspace of Bulgaria by the cloud of volcanic ash emitted from Etna volcano on December 31, 2013.

Table 2: Daily concentration of CO₂ in the air, wind direction and wind speed for the period 17 December 2013 – 13 January 2014

* In *Italic*, bold, are the days with the extreme high CO₂ concentration

Date	CO ₂ (ppm)	Wind direction	Wind speed (m/s)
17.12.2013	498.39	E-NE	10.09
18.12.2013	460.39	E-NE	9.93
19.12.2013	499.93	E-SE	4.54
20.12.2013	500.47	S-SE	2.50
21.12.2013	514.91	W-NW	3.07
22.12.2013	539.15	W-NW	2.72
23.12.2013	490.04	SW	3.32
24.12.2013	477.99	SW	8.94
25.12.2013	481.97	S-SW	4.14
26.12.2013	490.71	S	5.73
27.12.2013	499.45	S-SE	5.50
28.12.2013	461.59	E	3.37
29.12.2013	497.15	SE	4.98
30.12.2013	500.00	SW	2.24
31.12.2013	505.11	E-SE	1.40
1.1.2014	504.65	S-SE	3.05
2.1.2014	477.33	E-NE	2.23
3.1.2014	521.94	W-SW	4.10
4.1.2014	512.89	S-SE	4.66
5.1.2014	495.74	SW	6.75
6.1.2014	517.56	E-SE	3.52
7.1.2014	467.63	E-NE	5.37
8.1.2014	522.66	E-SE	3.52
9.1.2014	527.18	S-SW	4.18
10.1.2014	529.38	S-SW	5.55
11.1.2014	521.71	S-SW	5.98
12.1.2014	481.47	SE	5.13
13.1.2014	506.07	E-SE	4.88

The CO₂ concentrations in the atmosphere at the region of "BEO Moussala" continued to rise and its daily average value reached 500.00 ppm. The prevailing wind is southwest and had a relatively low average speed of over 2 m/s (Table 2).

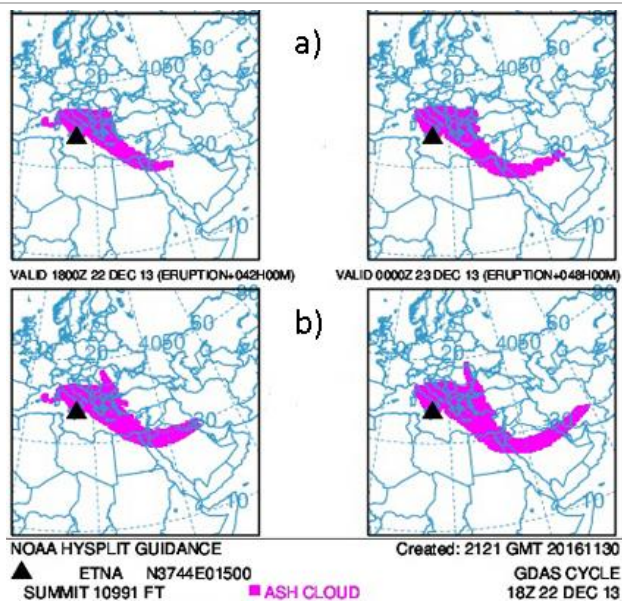


Fig. 3: Spread of volcanic ash from Etna volcano after eruption of December 22, 2013

- a) at a height between the earth surface and 20,000 feet (6,096 m)
b) at a height between the earth surface and 55,000 feet (16,764 m)

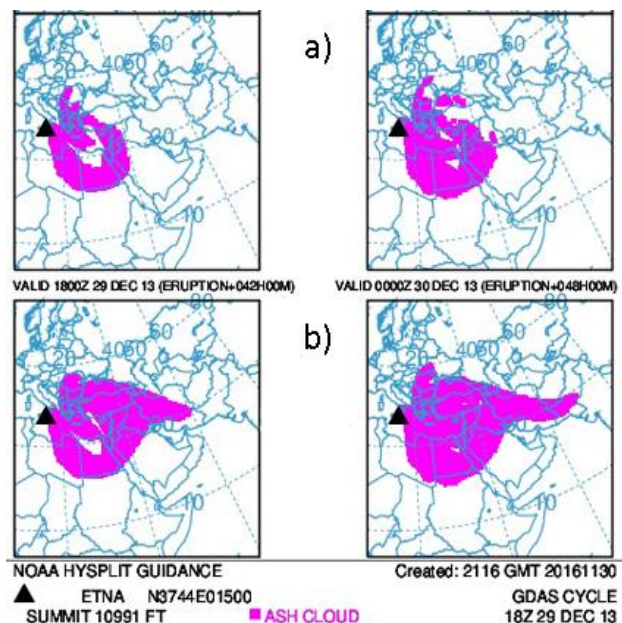


Fig. 4: Spread of volcanic ash from Etna volcano after eruption of December 28, 2013

- a) at a height between the earth surface and 20,000 feet (6,096 m)
b) at a height between the earth surface and 55,000 feet (16,764 m)

In most cases, the days with extremely high concentrations of CO₂ in the atmosphere are not observed during the days of volcano activation, but some days later. The Volcano Discovery database

shows that during the period comprised between 3 and 7 January, 2014 the activity of Etna volcano decreased, but on January 4, 2014, the wind direction had a southern component and high levels of CO₂ concentration in the air were established. This is probably a consequence of active ejection of volcanic ash and gases from the volcano in the previous days. The trace of the cloud of volcanic ash is described by the results of the model HYSPLIT (Fig. 5). The analysis of the model results allows us to assume that increased CO₂ concentration is associated with the spread of volcanic ash from eruptions of Etna volcano at the end of 2013 and at the beginning of 2014.

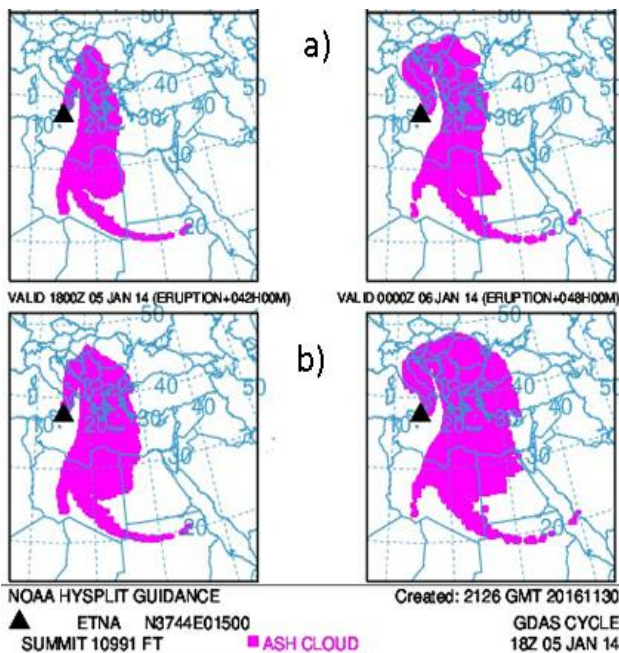


Fig. 5: Spread of volcanic ash from Etna volcano after eruption of January 4, 2014

- a) at a height between the earth surface and 20,000 feet (6,096 m)
- b) at a height between the earth surface and 55,000 feet (16,764 m)

The disposal of volcanic ash in the atmosphere from the northeast side of Etna continues on January 11, 2014 (Volcano Discovery). Volcanic ash is transported by the movement of air masses in the southeast and covers areas south of the territory of Bulgaria. The average daily CO₂ concentrations reported in the air were above 500 ppm. The wind speed was 5.98 m/s with the prevailing southwest direction (Table 2).

The analysis of large-scale circulation processes in the European region shows that during the days of Etna volcano activity and increased CO₂ concentration, the centers of low pressure are established in the region of northeastern Europe and

Iceland, while Southern Europe is in an area of high pressure. According to the air pressure field, the main air transport is from southern Europe, including the area of Etna volcano to the Central or Eastern Europe through the territory of Bulgaria (Fig. 6).

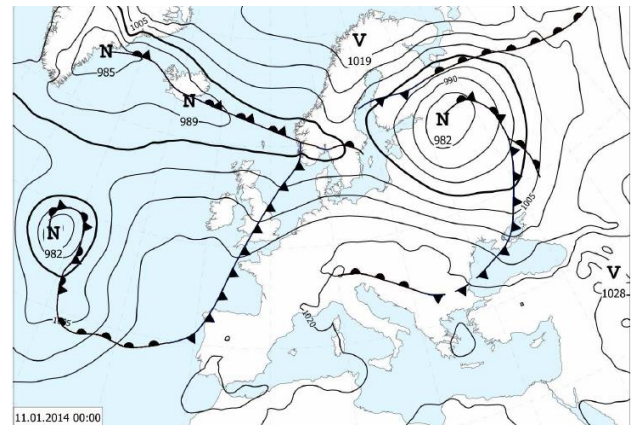


Fig. 6: Situation of air pressure centers in the European region on 11.01.2014. (Source: Bulletin Meteorologia a Klimatologia, 2014)

The location of air pressure centers in the atmosphere of the European region and determined by this factor transport of air masses confirm the role of activity of Etna volcano for the increased CO₂ concentrations in the atmosphere measured at the region of BEO Moussala, which reached extremely high levels.

In 15 cases of the above shown 18 days with extremely high concentrations of CO₂ the wind had a southern component and in 7 cases – a western component (Table 2). (The amount is more than the total number of days with extremely high concentrations, because in some of the days the wind had both southern and western components). It should be noted that the data about wind direction and speed given from the monitoring of BEO "Moussala" indicate the specific conditions in the region and considerably reflect local characteristics of the wind in relation to the nature of the relief. That is why there are other factors which contribute to the increasing CO₂ concentration in the studied period.

Conclusion

The data provided by BEO "Moussala", INRNE BAS, which are the basis of this study, show a rising trend in average monthly CO₂ concentrations in the air for the period comprised between 2007 and 2015, which is driven mainly by significant increases in 2013-2015.

The analysis of the results obtained from the database of BEO "Moussala" and NOAA HYSPLIT model clearly shows the influence of the natural

factor (the eruption of Etna volcano) as a cause for the increasing CO₂ concentration in the atmosphere. For the period December 17, 2013 - January 13, 2014, 18 days with extreme high concentration of CO₂ are registered. In this period, Etna volcano emits volcanic gases and ash, a part of which are transported by the movement of air masses to the airspace of Bulgaria and an increasing in the concentration of CO₂ in the air at the BEO "Moussala" is registered.

The analysis shows that the activity of Etna volcano is not the only factor for the increased CO₂ concentration in the air. Regarding to this, more detailed analyses in this area would be made in subsequent studies.

Acknowledgement

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The Mediterranean Oscillation (MOI) and the Forest Fires in Romania in the Period 1986–2014

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Abstract

The study examines the connection between the Mediterranean Oscillation (MOI) and the forest fires (the annual number of fires, the annual burned area and the average burned area per fire) in Romania in the period 1986–2014. Pearson's correlation coefficient (R) was used for determination of the correlation connection. Two MOI datasets were used: MOI-1 (Algiers and Cairo) and MOI-2 (Israel and Gibraltar). Monthly, seasonal and annual values of MOI were used in the calculations. Results for the number of fires and MOI-1: the highest values of R (statistically significant at the level of $p \leq 0.05$) were obtained for April (–0.446) and June (0.423), and for summer (0.432). The annual burned area and MOI-1: the highest values of R (statistically significant at the level of $p \leq 0.05$) were obtained for April (–0.459), and for winter (0.406). The number of fires and MOI-2: the highest values of R (statistically significant at the level of $p \leq 0.01$) were obtained for June (0.556) and February (0.475), and for summer (0.507). The annual burned area and MOI-2: the highest values of R (statistically significant at the level of $p \leq 0.05$) were obtained for June (0.449) and February (0.439), and for summer (0.439). Results of the research could be used for the long-term forecast of forest fires in Romania. However, further investigations of the connection between forest fires and other climate indices are necessary.

Keywords: *Mediterranean Oscillation, forest fires, burned area, Romania*

Rezumat. Indicele oscilației mediteraneene (IOM) și incendiile de pădure din România în perioada 1986-2014

Articolul examinează conexiunile dintre Indicele Oscilației Mediteraneene (IOM) și incendiile de pădure (numărul anual de incendii, suprafața arsă anual și suprafața medie afectată de un incendiu) din România în perioada 1986-2014. În acest scop, a fost utilizat coeficientul de corelație Pearson (R) pentru a determina corelațiile. Au fost folosite două seturi de date privind IOM: IOM-1 (Algiers și Cairo) și IOM-2 (Israel și Gibraltar), pentru calcule bazându-se pe valorile lunare, sezoniere și anuale ale IOM. Rezultatele pentru numărul de incendii și IOM-1: cele mai mari valori ale lui R (semnificative statistic la nivel de $p \leq 0,05$) au fost obținute pentru luna aprilie (–0,446) și iunie (0,423), și pentru vară (0,432). Suprafața arsă anuală și IOM-1: cele mai mari valori ale lui R (semnificative statistic la nivel de $p \leq 0,05$) au fost obținute pentru luna aprilie (–0,459) și pentru iarnă (0,406). Numărul de incendii și IOM-2: cele mai mari valori ale lui R (semnificative statistic la nivel de $p \leq 0,01$) au fost obținute pentru luna iunie (0,449) și februarie (0,475), precum și pentru sezonul de vară (0,507). Suprafața arsă anuală și IOM-2: cele mai mari valori ale lui R (semnificative statistic la nivel de $p \leq 0,05$) au fost obținute pentru luna iunie (0,449) și februarie (0,439), precum și pentru vară (0,439). Rezultatele cercetării ar putea fi folosite și pentru previziunile pe termen lung asupra incendiilor de pădure din România. Totuși, sunt necesare și alte investigații în ceea ce privește legătura dintre incendiile de pădure și alți indici climatici.

Cuvinte-cheie: *Indicele Oscilației Mediteraneene, incendiile de pădure, suprafață arsă, România*

Introduction

Forest fires are among the greatest ecological threats in European countries. One of the countries seriously affected by forest fires is Romania. During last three decades the most extreme forest fire season in Romania was 2012 (911 fires, total burned area 6624 ha). Extreme fire seasons were also in 2000, 2002 and 2007 (<http://forest.jrc.ec.europa.eu/effis/reports/annual-fire-reports/>).

The connection between climate and forest fires is a subject of numerous researches. The influences of teleconnections on forest fires are especially interesting. Teleconnections are impacts of distant climate phenomena to the climate of some region.

These impacts have been mostly investigated for North America (Norman & Taylor, 2003; Schoennagel et al, 2005; Sibold & Veblen, 2006; Schoennagel et al., 2007; Morgan et al., 2008; Milenković et al., 2016a). The authors mostly emphasize the importance of Atlantic Multidecadal Oscillation (AMO), Pacific Decadal Oscillation (PDO) and El Niño-Southern Oscillation (ENSO). There is also the impact of AMO on forest fires in Europe. Milenković et al. (2016b) established the connection between AMO and the forest fires in France (number of fires, total burned area and average burned area per fire). However, due to distance, the impact of AMO is weaker in East and Southeast Europe. Thus, the aim of this paper was to examine the connection between MOI and the forest fires in Romania.

There are two versions of MOI. The first one (MOI-1) is defined as the normalized pressure difference between Algiers and Cairo (Conte et al., 1989; Palutikof et.al., 1996) and the second one (MOI-2) is calculated from Gibraltar's Northern Frontier and Lod Airport in Israel (Palutikof, 2003). The influence of MOI on climate, primarily air temperature and precipitation, has been confirmed in the researches (Maheras & Kutiel, 1999; Supić et al., 2004; Burić et al., 2014, Schmuck et.al. 2015).

Material and methods

The study used monthly, seasonal and annual values of Mediterranean Oscillation Index (MOI). Both MOI-1 (Algiers and Cairo) and MOI-2 (Israel and Gibraltar) datasets were used. The data were taken from Climatic Research Unit, University of East Anglia, Norwich, UK:

- <https://crudata.uea.ac.uk/cru/data/moi/moi1.0.utput.dat>
- <https://crudata.uea.ac.uk/cru/data/moi/moi2.0.utput.dat>

The data on the forest fires in Romania in the period 1986–2014 covered:

- Total annual number of forest fires (N)
- Total annual burned area (P)
- The average burned area per fire (P/N)

The data were taken from the European Commission Report – Forest Fires in Europe, Middle East and North Africa 2014, Joint Report of JRC and Directorate-General Environment (2015):

- <http://forest.jrc.ec.europa.eu/effis/reports/annual-fire-reports/>

Pearson correlation coefficient (R) on the basis of linear trend was used for the calculation of correlation, and statistical significance was tested on $p \leq 0.05$ and $p \leq 0.01$. Monthly, seasonal and annual MOI-1 and MOI-2 values were used in the calculations, and one year phase shift was also performed (values from previous year were used). Calculation for the same year didn't use data for the period September to December, since the main fire season in Romania ends in September.

Statistical significance of linear trend was determined for $n-2$ and on the basis of the coefficient of determination (R^2 , attached to the charts). For the testing of the significance of linear trend t test was used:

$$t = R \sqrt{\frac{n-2}{1-R^2}}$$

wherein R^2 - the coefficient of determination; n - the length of the series.

Results and discussions

In Romania in the period 1986–2014 an increasing trend of the annual number of forest fires was recorded (Fig. 1). On the basis of table values it was determined that the trend is not statistically significant at $p \leq 0.05$.

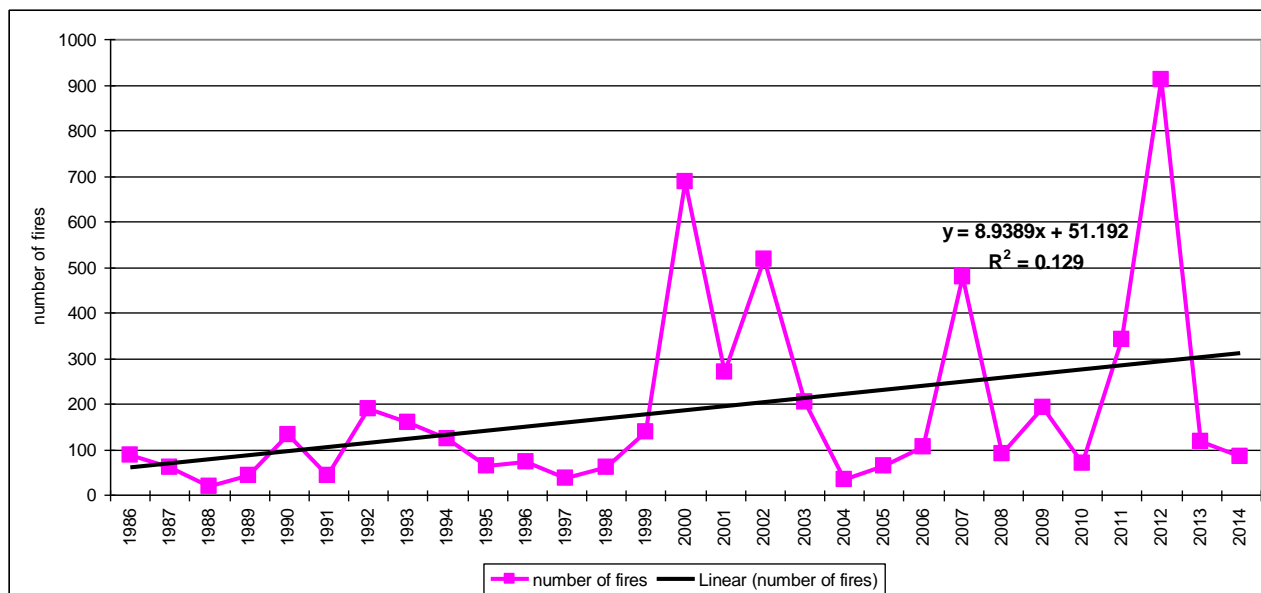


Fig. 1: The annual number of forest fires in Romania (1986–2014) with the trend line
 Source of data: <http://forest.jrc.ec.europa.eu/effis/reports/annual-fire-reports/>

In the same period an increasing trend of the total annual burned area was also noted (Fig. 2). On

the basis of table values it was determined that the trend is statistically significant at $p \leq 0.05$.

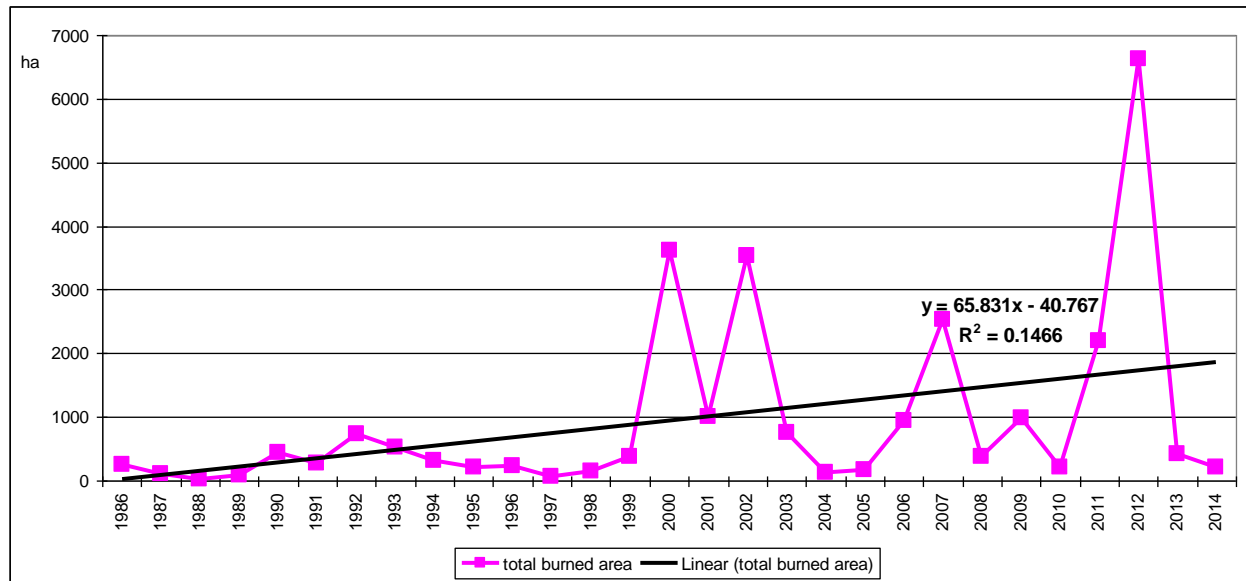


Fig. 2: The annual burned area in Romania (1986–2014) with the trend line

Source of data: <http://forest.jrc.ec.europa.eu/effis/reports/annual-fire-reports/>

The average burned area per fire has also increasing trend in the period 1986–2014 (Fig. 3). On the basis of table values it was determined that the trend is statistically significant at $p \leq 0.05$.

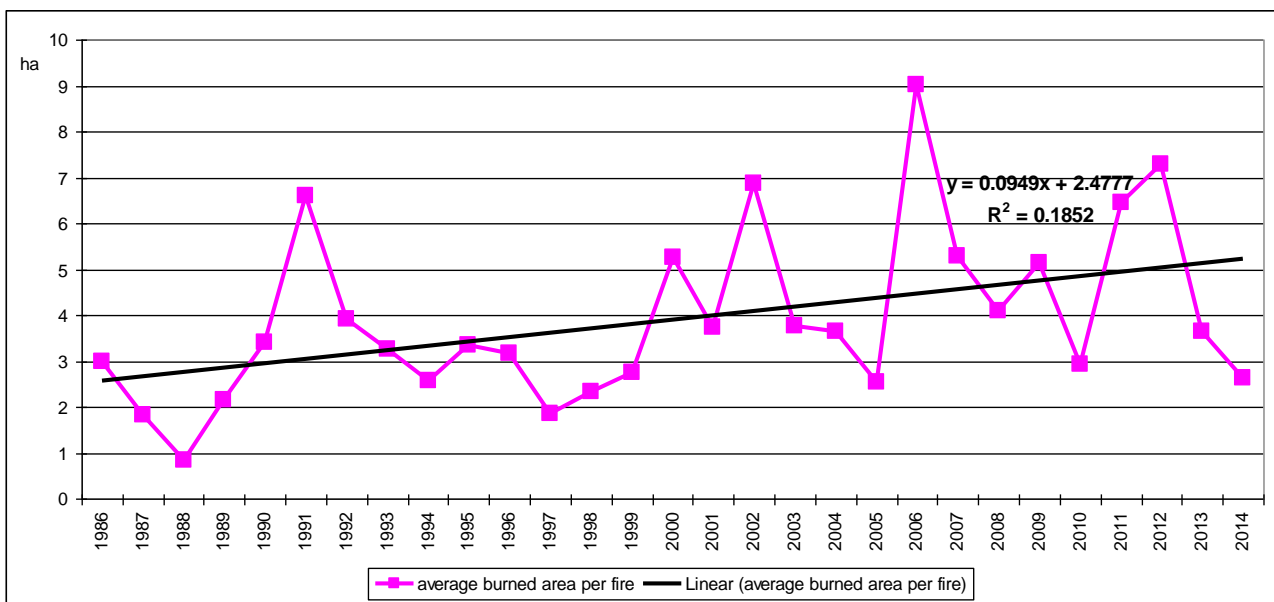


Fig. 3: The average burned area per fire in Romania (1986–2014) with the trend line

Source of data: <http://forest.jrc.ec.europa.eu/effis/reports/annual-fire-reports/>

Table 1 shows the results of the research of the correlation between MOI-1 and the forest fires in Romania (1986–2014).

In the calculation with the forest fire data and MOI-1 there weren't any values of R statistically significant at $p \leq 0.01$. With the number of fires the highest values of R (statistically significant at $p \leq 0.05$) were obtained for April (-0.446) and June (0.423) at monthly level, and at seasonal level for

summer (0.432). In the calculation with the annual burned area the highest values of R were obtained for April (-0.459), and for winter (0.406). In the calculation with the average annual burned area per fire in only one case the value of R was statistically significant at $p \leq 0.05$. It was for June MOI-1 (0.375). With the 1 year phase shift the values of R were lower.

Table 1: Pearson correlation coefficient (R): MOI-1 – forest fires in Romania in the period 1986–2014 (N – the number of fires, P – the annual burned area, P/N – the average annual burned area per fire)

	MOI-1 – monthly values											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Avg	Sep	Oct	Nov	Dec
N	0.317	0.393*	0.060	- 0.446*	0.381*	0.423*	0.210	0.203	-	-	-	-
P	0.323	0.364	0.070	- 0.459*	0.347	0.365	0.221	0.180	-	-	-	-
P/N	0.235	0.139	-0.286	0.020	0.337	0.375*	0.126	0.194	-	-	-	-
	MOI-1 – seasonal and annual values											
	Winter			Spring		Summer		Autumn		Annual		
N	0.417*			0.051		0.432*		-		0.376*		
P	0.406*			0.037		0.391*		-		0.361		
P/N	0.226			-0.073		0.364		-		0.333		
	MOI-1 – monthly values (phase shift – 1 year)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Avg	Sep	Oct	Nov	Dec
N	-0.061	0.108	- 0.369*	0.238	0.080	0.254	- 0.292	- 0.025	-0.044	0.225	-0.123	0.185
P	-0.101	0.078	-0.347	0.320	0.139	0.241	- 0.286	0.003	0.055	0.239	-0.168	0.182
P/N	0.239	0.131	-0.156	0.334	0.211	0.153	- 0.035	0.364	0.079	0.068	-0.263	0.101
	MOI-1 – seasonal and annual values (phase shift – 1 year)											
	Winter			Spring		Summer		Autumn		Annual		
N	-0.029			-0.180		0.027		0.015		0.042		
P	-0.100			-0.095		0.035		0.033		0.051		
P/N	0.034			0.117		0.260		-0.134		0.249		

* significant $p \leq 0.05$, ** significant $p \leq 0.01$

Table 2 shows the results of the research of the correlation between MOI-2 and the forest fires in Romania (1986–2014).

Table 2: Pearson correlation coefficient (R): MOI-2 – forest fires in Romania in the period 1986–2014 (N – the number of fires, P – the annual burned area, P/N – the average annual burned area per fire)

	MOI-2 – monthly values											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Avg	Sep	Oct	Nov	Dec
N	0.239	0.475**	0.015	-0.234	0.364	0.556**	0.168	0.259	-	-	-	-
P	0.239	0.439*	0.025	-0.274	0.295	0.449*	0.169	0.238	-	-	-	-
P/N	0.159	0.143	-0.299	0.020	0.161	0.200	- 0.013	0.121	-	-	-	-
	MOI-2 – seasonal and annual values											
	Winter			Spring		Summer		Autumn		Annual		
N	0.446*			0.077		0.507**		-		0.393*		
P	0.418*			0.044		0.439*		-		0.357		
P/N	0.162			-0.186		0.155		-		0.199		
	MOI-2 – monthly values (phase shift – 1 year)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Avg	Sep	Oct	Nov	Dec
N	-0.144	0.151	- 0.415*	0.008	0.019	0.217	- 0.306	0.080	-0.033	0.098	-0.113	0.198
P	-0.165	0.146	- 0.427*	0.026	0.060	0.173	- 0.280	0.066	0.052	0.085	-0.159	0.177
P/N	0.174	0.075	-0.306	0.048	0.146	0.031	- 0.152	0.105	0.022	-0.111	-0.267	0.032
	MOI-2 – seasonal and annual values (phase shift – 1 year)											
	Winter			Spring		Summer		Autumn		Annual		
N	-0.098			-0.342		-0.074		-0.057		-0.059		
P	-0.153			-0.329		-0.078		-0.076		-0.080		
P/N	-0.074			-0.184		-0.008		-0.260		-0.043		

* significant $p \leq 0.05$, ** significant $p \leq 0.01$

In the calculation with the number of fires and MOI-2 the highest values of R (statistically significant at $p \leq 0.01$) at the monthly level were obtained for June (0.556) (Fig. 4) and February (0.475), and at seasonal level for summer (0.507). With the annual burned area and MOI-2 the highest

values of R (statistically significant at $p \leq 0.05$) were obtained for June (0.449) (Fig. 5) and February (0.439), and for summer (0.439). In the calculation with the average annual burned area per fire there weren't any statistically significant values of R.

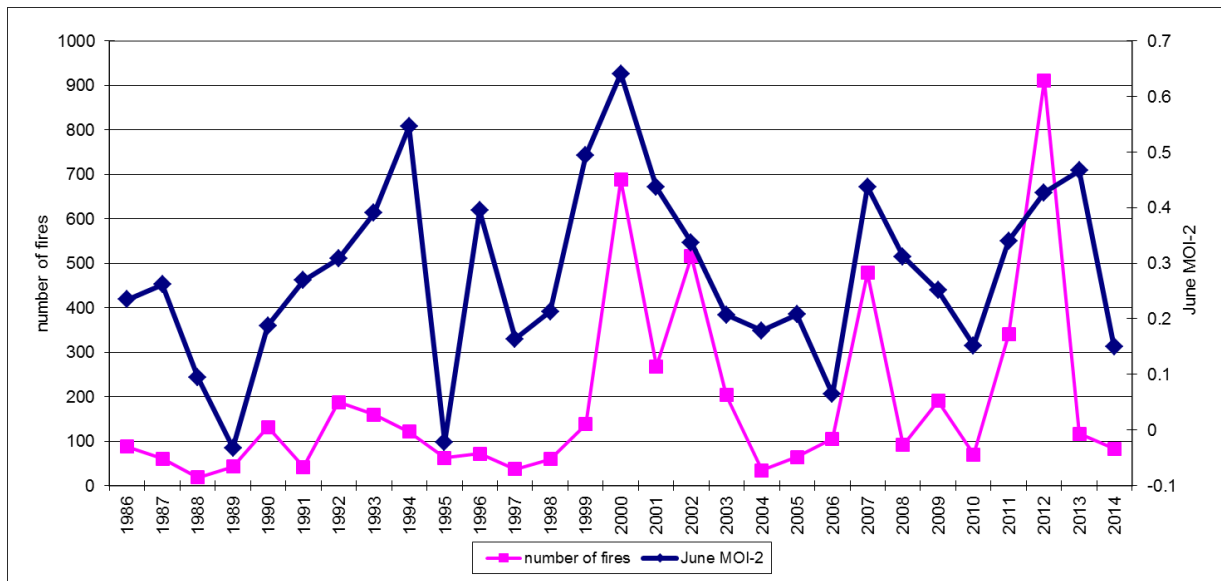


Fig. 4: The number of fires in Romania (1986–2014) and MOI-2 values for June: $R=0.556$ (significant $p \leq 0.01$)

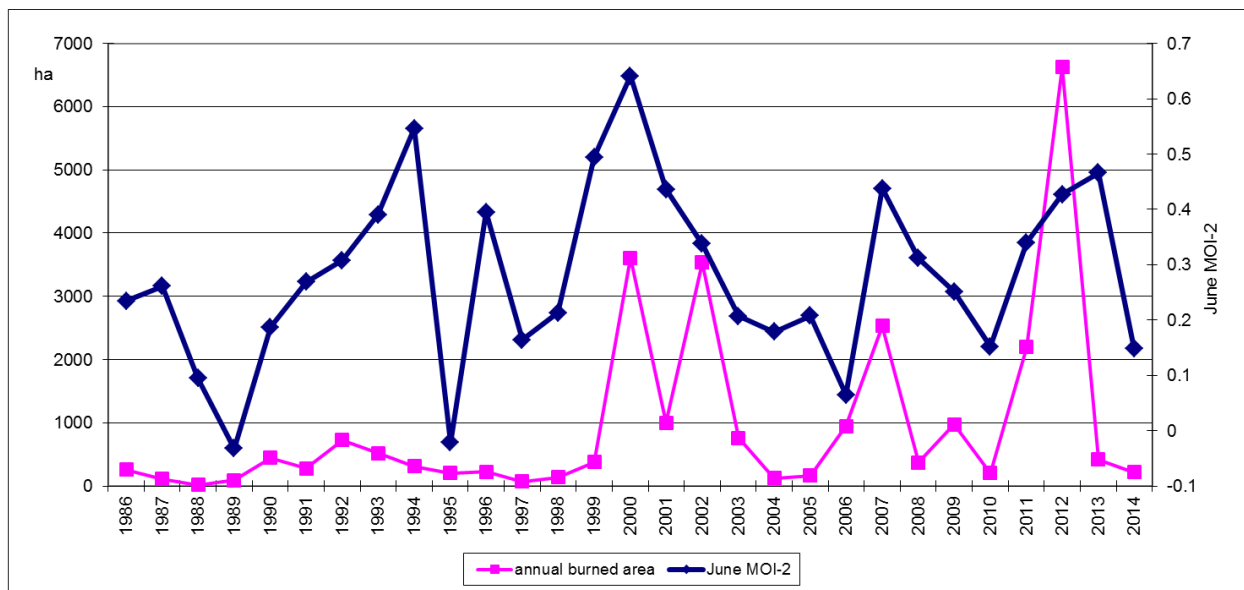


Fig. 5: The annual burned area in Romania (1986–2014) and MOI-2 values for June: $R=0.449$ (significant $p \leq 0.05$)

Therefore, the connection between MOI-2 and the forest fire data for Romania in the period 1986–2014 is stronger than the same connection for MOI-1. The results of the research could possibly be used as a basis for the long-term forest fire forecast. The short-term forecast should be based on the connection between the solar wind parameters and forest fires (Radovanović et al., 2013; Radovanović et al., 2015a; Radovanović et al., 2015b; Radovanović et al., 2015c). In the future more researches on different climate indices and solar

wind parameters are necessary for the improvement of the forest fire forecast.

Important step in the future research should be the analysis of the connection between MOI and forest fires on the regional level. Forest fires are unevenly distributed in Romania. The greatest number of forest fires and the greatest burned area during the period 1968–2000 were recorded in the counties Caraș-Severin, Hunedoara, Gorj, Alba, Cluj and Maramureș. The months with the greatest fire activity by seasons were March–April, August and

November (Ene, Ciobanu & Borz, 2011). During the period 1990–2003, Caras-Severin, Gorj and Mehedinți counties were the most severely affected by forest fires (Adam & Ureche, 2007). These three counties are located in the Southwestern part of Romania close to the border with Serbia. On the other side of the border, in Serbia, there is also a highly endangered area by fires – Deliblatska peščara (Milenković, Radovanović & Ducić, 2011).

The assessment of fire risk on the basis of the vegetation cover is very important for the efficient forest fire protection. In Romania many fires spread into the forest from the surrounding agricultural areas on which some cleaning actions with the help of fire are implemented (Adam, 2007).

Conclusion

In Romania, during the 1986–2014 period, increasing trends in the annual number of forest fires, total annual burned area and the average burned area per fire were recorded.

With MOI-1 and the number of fires the highest values of R (statistically significant at $p \leq 0.05$) were recorded for April (–0.446), June (0.423) and summer (0.432). In the calculation with MOI-1 and the annual burned area the highest values of R were obtained for April (–0.459) and winter (0.406), and with the average annual burned area per fire for June MOI-1 (0.375). With the 1 year phase shift recorded R values were lower.

With the number of fires and MOI-2 the highest values of R (statistically significant at the level of $p \leq 0.01$) were obtained for June (0.556), February (0.475) and summer (0.507). In the case of the annual burned area the highest values of R (statistically significant at $p \leq 0.05$) were recorded for June (0.449), February (0.439) and summer (0.439). At the average annual burned area per fire there weren't any statistically significant values of R.

The results of the research could be used in the long-term forest fire forecast.

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The study used data from the European Commission Forest Fires in Europe, Middle East and North Africa 2014, Joint Report of JRC and Directorate-General Environment (2015).

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Shape characteristics of fluvial islets based on GIS techniques. A case study: the Danube's islets between Giurgiu and Oltenița

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Abstract

This study aims to quantitatively characterize shape parameters of fluvial islets using GIS techniques. There were eight metrics selected for the analysis. For the automation of the workflow, all processing functions were joined into a single graphical model. For this case study we selected the Danube sector situated between the cities Giurgiu and Oltenița. We chose to track the evolution of the fluvial islets' shapes from 1864 to 2010. Information was extracted from historical data sources such as maps and orthophotoplans. The graphical model created was run for each studied year.

The results show major changes in the aspect of fluvial islets along the Danube reach. Between 1864 and 2010 the number of islets slightly increased with the total area ranging from 21.19 kmp to 27.96 kmp. In the period studied, the shape turned from a rounded aspect to a more elongated one. Knowledge of the information on the shape of those landforms is relevant for river restoration strategies, nature conservations of islets and maintenance of the protected habitats.

Keywords: *fluvial islets, Danube, shape, GIS, graphical model*

Rezumat. Caracteristici de formă ale insulelor fluviale bazate pe tehnici SIG. Studiu de caz: insulele Dunării între Giurgiu și Oltenița

Scopul acestui studiu este de a descrie cantitativ aspectul insulelor fluviale utilizând tehnicile GIS. În acest sens, au fost selectați pentru analiză opt parametri morfometrici. Pentru automatizarea fluxului de lucru, toate funcțiile folosite pentru calcularea parametrilor au fost grupate într-un model conceptual. Ca studiu de caz a fost ales sectorul dunărean Giurgiu – Oltenița. Evoluția formei insulelor fluviale a fost urmărită pentru intervalul 1864 – 2010. Informațiile au fost extrase din surse de date istorice precum hărțile vechi și ortofoplanuri. Modelul conceptual creat a fost rulat pentru fiecare an analizat.

Rezultatele ilustrează schimbări majore în aspectul insulelor fluviale dunărene prezente în sectorul studiat. Între 1864 și 2010 numărul insulelor a crescut ușor, iar suprafața totală a acestora a variat de la 21.19 kmp la 27.96 kmp. În perioada studiată forma insulele fluviale a evoluat de la un aspect circular la unul alungit. Cunoașterea informațiilor privind forma acestor formațiuni geomorfologice este relevantă pentru strategiile de reconstrucție ecologică în lungul râurilor/fluviilor, conservarea și menținerea habitatelor protejate.

Cuvinte-cheie: *insule fluviale, Dunăre, formă, SIG, model conceptual*

Introduction

Shape describes the geometric form of individual spatial objects (Maceachren, 1985). It holds an important role in many fields such as Spatial Science, Mathematics, Computer or Cognitive Science. Nevertheless, the definitions, goals and applications in each discipline are little different. In geography, shape has been primarily used as a descriptive tool (Boyce&Clark, 1964), but the need for a quantitative measure of shape that could address geographical phenomena first came up during the quantitative revolution in the 1960's (Sovik, 2014). The evaluation of shape is challenging simply due to the fact that there is no universally agreement upon definition on how to quantify it. Shape indices tend to fall into two classes: 1) single parameter – such as area or perimeter calculations and 2) multiple parameter – involving more complex mathematical functions (Sovik, 2014; Marin, 2016).

A fluvial islet is a landform within a river channel, surrounded by stream-channel branches or waterways, which has some stability and remains

exposed during bankfull flow (Picco et al., 2014; Wyrick, 2005). On the geologic time scale, a fluvial islet may not be permanent due to natural or human induced hydrological changes, but can remain in place over a long period. In the literature, the term of stability for fluvial islets is not usually defined precisely, but often the vegetation is a good indicator for this (Wyrick, 2005).

Fluvial islets are present in the channels of the most rivers. They result from complex processes that take place in the river channel and have a morphological, an ecological and economic importance. Also, they are good indicators of the natural state of a river system and are largely influenced by changes in hydrological parameters and anthropogenic activities (Picco et al., 2014, Sadek, 2012). For these reasons, river islets have sparked the interest of many researchers. Significant studies have been carried out to investigate the morphology and morphometry of fluvial islets (Wyrick, 2005; Ricaurte et al., 2012, Kiss&Andrási, 2014; Raslan&Salama, 2015).

The purpose of this paper is to quantitatively characterize shape parameters of fluvial islets, using

Open Source GIS techniques. There were eight metrics selected for the analysis, namely: Islets number (IN), Length (L), Width (W), Elongation Ratio (ELONG), Area (A), Perimeter (P), Perimeter-Area Ratio (P/A), Shape Index (SI). For the work flow automation all processing functions were joined into a single graphical model.

Study area

The Danube River is the second longest river in Europe, with a length of 2.850 kilometers. It rises from the Black Forest (Germany) and flows to southeast to the Black Sea. The Danube course is divided into three main sectors: Upper Sector (from source to Bratislava city), Middle Sector (from Bratislava city to Bazias) and Lower Sector (from Bazias to the Black Sea) (Tockner et al., 2008).

The Lower Course flows over a distance of 1075 km (Gâstescu&Țuchiu, 2012), between Bazias and Sulina City and touches the borders of Serbia, Bulgaria, Moldova and Ukraine (Buzea, 2010). Two large dams (Iron Gate 1 and Iron Gate 2) were built in the Lower Danube. This System induced some modifications of natural river regime such as reduced sediment transport capacity, followed by sediment deposition (Mladenovic et al., 2013). Also the embankment and drainage activities have altered floodplain and fluvial islets geomorphic processes (Constantinescu et al., 2015).

For the analysis presented in this paper, we chose as study case the fluvial islets from Danube sector situated between the Romanian localities Giurgiu and Oltenița (Fig. 1).

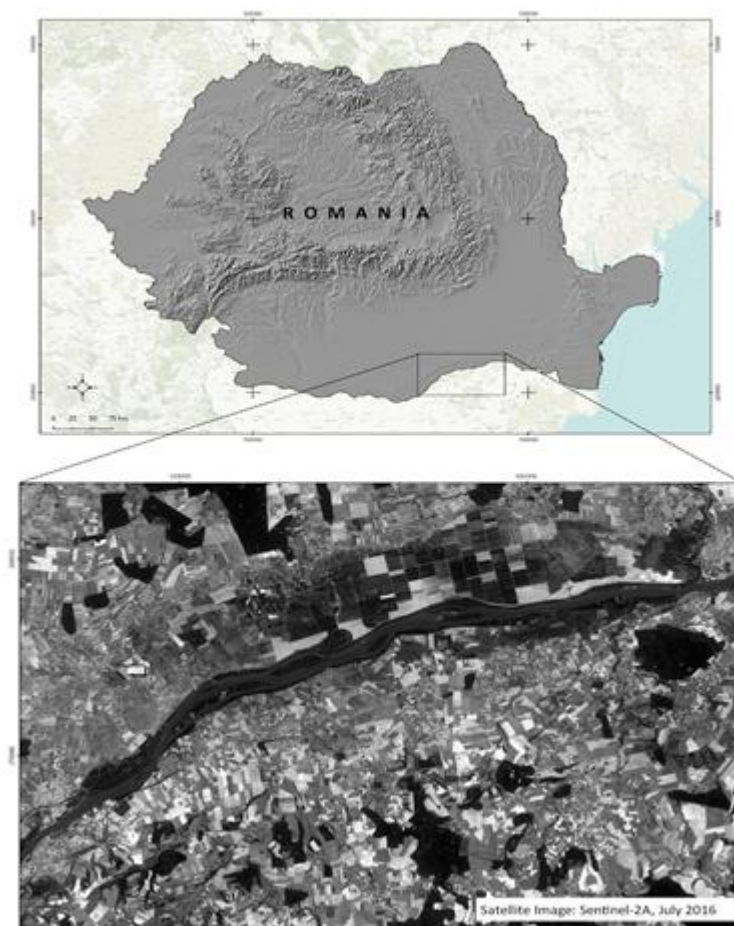


Fig. 1: Location of the study area

Database and methodology

In this paper we employed a diachronic study to investigate the shape characteristics of islets along the selected Danube River reach. We used historical maps and air photographs from different dates, but with similar scales (Table 1): Map of Southern Romania, Romanian maps under Lambert-Cholesky

projection system - called "Planurile Directoare de Tragere", Romania Topographic maps and orthophotoplan from 2010. It should be noted that all maps used in this study are based on the topographic survey. So, we consider that their accuracy is reasonable. For example, the Austrian topographic survey between 1855 and 1859 served as a basis for the Map of Southern Romania (Bartos

et al., 2014), which was printed in 1864 to Viena (Popescu-Spinteni, 1978). Romanian maps under Lambert-Cholesky projection system are the results of a series of Romanian, Russian and Austrian measurements and Topographic Map of Romania was made on the topographic and aerial survey between 1872-1980 (Năstase&Osaci, 2005).

It's important to mention that an inconvenience of using old maps and aerial imagery are the intervals

between timepoints which are not equals, so the data isn't uniform. For this reason, the interpretation of the changes in the number of fluvial islets and their morphometric parameters takes into account the possibility of intermediate positionings and aspects, which have not been captured by existing cartographic and imagery documents.

Table 1: Description of the Historical Maps and Imagery Documents used in the analysis

Type of Data	Name (Source of download)	Year	Scale/Resolution
Maps	The Szathmary Map - „Charta Romaniei Meridionale” (http://charta1864.ro/)	1864	1:57.600
	1: 20.000 Romanian maps under Lambert-Cholesky projection system - called Planurile Directoare de Tragere (http://earth.unibuc.ro/download)	1920	1:20.000
	Topographic Map of Romania (http://opengis.unibuc.ro/)	1980	1:25.000
Ortophoplans	Ortophoplan of Romania (DTM)	2010	1:5.000

We chose a simple distinction between bars and islets based on the absence (bars) and presence (islets) of vegetation (Nicholas et al., 2013). So, the boundaries of all positive landforms of the river were digitized and islets were separated from bars using the vegetation criteria. To explore the shape

characteristics dynamics of fluvial islets we calculated a set of commonly used landscape metrics, based on the GIS shapefiles (Table 2). It should be noted that we used only Open Source GIS Software, such as WhiteBox GAT, Quantum GIS and SAGA GIS.

Table 2: The 8 landscape metrics, with their abbreviations, formulas and meaning

Parameters	Abbreviation	Formula	Meaning
Islets number	IN	$IN=n$	Total number of fluvial islets from study area.
Length	L		Length (m) of each islet.
Width	W		Width (m) of each islet.
Elongation Ratio	ELONG	L/W	Is a measure of the length/width
Islet Area	Ai	$A_i = A/1000000$	Area (m ²) of each islet, divided by 1000000 to convert to km ² .
Islet Perimeter	Pi	$P_i = P/1000$	Perimeter (m) of each islet, divided by 1000 to convert to km.
Perimeter-Area Ratio	P/A	P_i/A_i	Is the ratio of perimeter and area.
Shape Index	SI	$100 * P_i/(2*\sqrt{(n*A_i)})$	Shape Index is based on the ratio of perimeter to the square root of area.

It was a challenge to find a way to automatically calculate the length and width of each islet. Geometrically, they have an irregular shape, which makes it difficult to establish the parameters mentioned above by a computer. Thus, each irregular polygon needs to be framed by a rectangular polygon, which rotates according to the orientation of the original polygon. In literature, this operation is known as Minimum Bounding Rectangle (MBR), a 2-dimensional case of the Minimum Bounding Box (MBB). The number of open source GIS software that have implemented such an instrument is limited. We have identified and selected Whitebox GAT software for the creation of minimum bounding rectangles and automatic calculation of the maximum length and width. It should be noted that we chose this approach because we believe that the determination on maps

or aerial images manually by using a measuring instrument is time consuming and involves a high degree of subjectivity.

For the automation of the work flow, most of the processing functions were joined into a single graphical model (Fig. 2), using the specific tool from Quantum GIS. The graphical model created has been run for each studied year.

Results and discussions

Count and area of fluvial islets

In the Danubian watercourse between Giurgiu and Oltenița, for the entire studied period, it can be noted a large number of islets, with a maximum recorded in the 1920. The smaller number of river islets found before 1920 and the lower total area obtained for 1864 and 1920, can be explained by the aggressiveness of the floods registered in 1850,

1862, 1897, 1899 (Upper Danube) and in 1862, 1895 and 1897 (Lower Danube) (Melo et al., 2014). After 1920, the number of fluvial islets is preserved over 20, but overall it can be observed a slight downward trend of those. This can be associated with the anthropogenic activities from the upstream sector (the construction of the Iron Gates I and II), the embankment of the minor bed of the Danube River, lower sediment transport rates, wave actions and water streams led to physical degradation through reducing riverbed depth, sandbanks forming

and islets. Analyzing the islets dynamics on different cartographical documents and images, it was possible to observe some changes in the active channel area during different periods. For example, the largest islets, remaining in the Danube watercourse over time, it can be observed a slightly downstream migration. Also, some fluvial islets were merged together into one islet, other merged into the river bank; some of them disappeared, while new ones were formed.

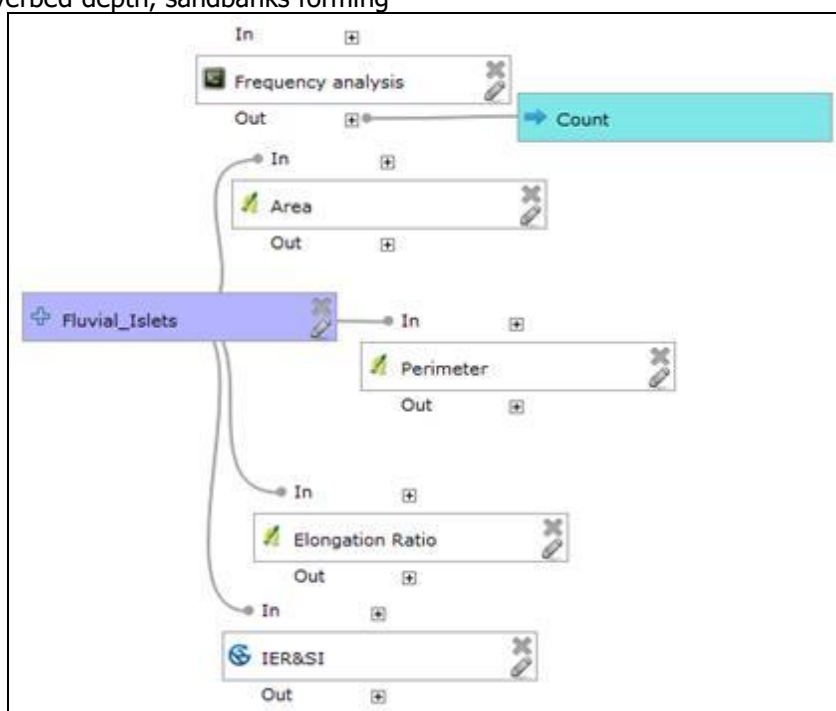


Fig. 2: The graphical model used in this study (Marin, 2016)

In the 1920-2010 period, the total area of river islets fluctuated, increasing and decreasing over time. The flood events occurred during the study period may have influenced the area and the morphology of river islets. For example, between

1920 and 1980 there have been five significant floods 1930, 1940, 1942, 1955 and 1970 (Pătruț, 2010) and between 1980 and 2010, four floods with major impact were identified: 1981, 2005, 2006, 2010 (Teodor et al., 2010) (Fig. 4).

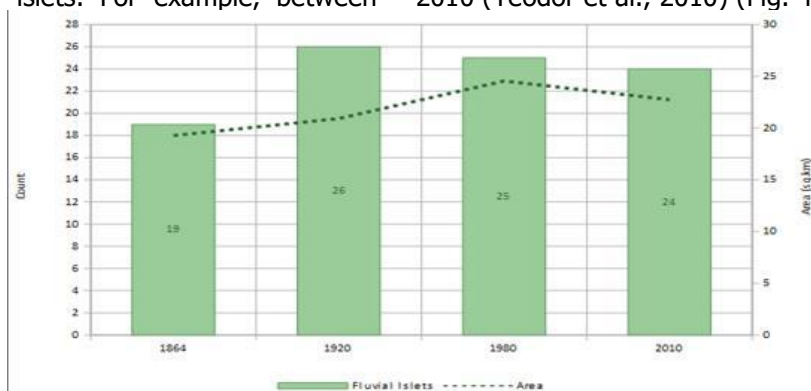


Fig. 3: Number of fluvial islets and total area

Elongation Ratio

Elongation ratio known as aspect ratio (Wyrich, 2005) is a measure of the length/width. It refers to

the energy conditions of the river around the fluvial islets (Kiss&Andrasi, 2014). Using the classification proposed by Kiss T. and Andrasi G. (2014), we identified four classes: $ELONG \leq 2$ for mostly

round shape; $2 < \text{ELONG} \leq 4$ for round shape; $4 < \text{ELONG} \leq 6$ for elongated shape and $\text{ELONG} < 6$ for strongly elongated shape.

In Fig. 5, we observe that in 1864, most of the islets have elongation ratio between 2 and 4, which shows that their shape is round. Later, in 1920, of the 26 fluvial islets, 10 of them have a round shape and therefore fit in the category of elongated islets. After '79-'80 years, the number of islets with elongated shape and strongly elongated shape

increase to 24. It seems that the fluvial islets tend to reshape by elongating because of the reduction of its width. The high values of elongation ratio achieved in 2010 show that the general trend of the shape of river islets is to turn from a rounded aspect to a more elongated one. That means after '80 years the energy conditions of rivers is higher in the neighborhood of islets, so these landforms can develop dynamically (Kiss&Andrasi, 2014).

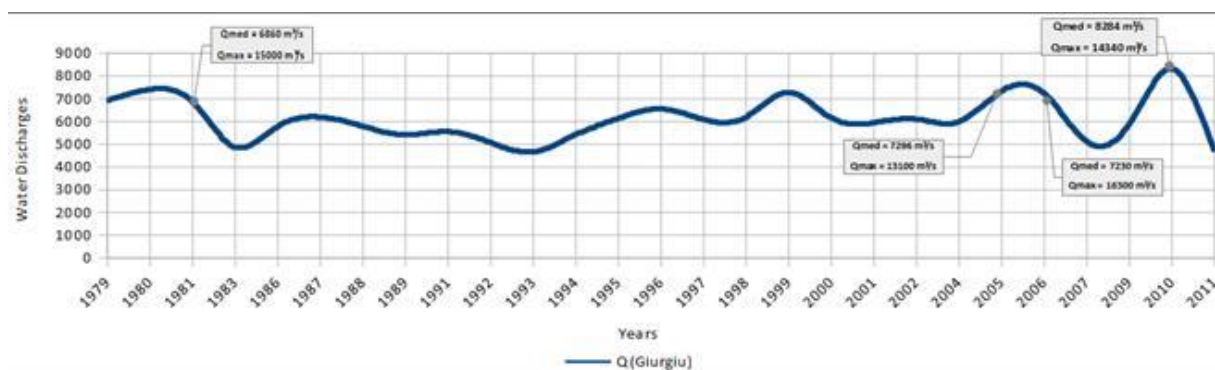


Fig. 4: Graphical representation of the annual average of water discharges at Giurgiu Station
 (Source of data: Hydrological Station, Giurgiu)

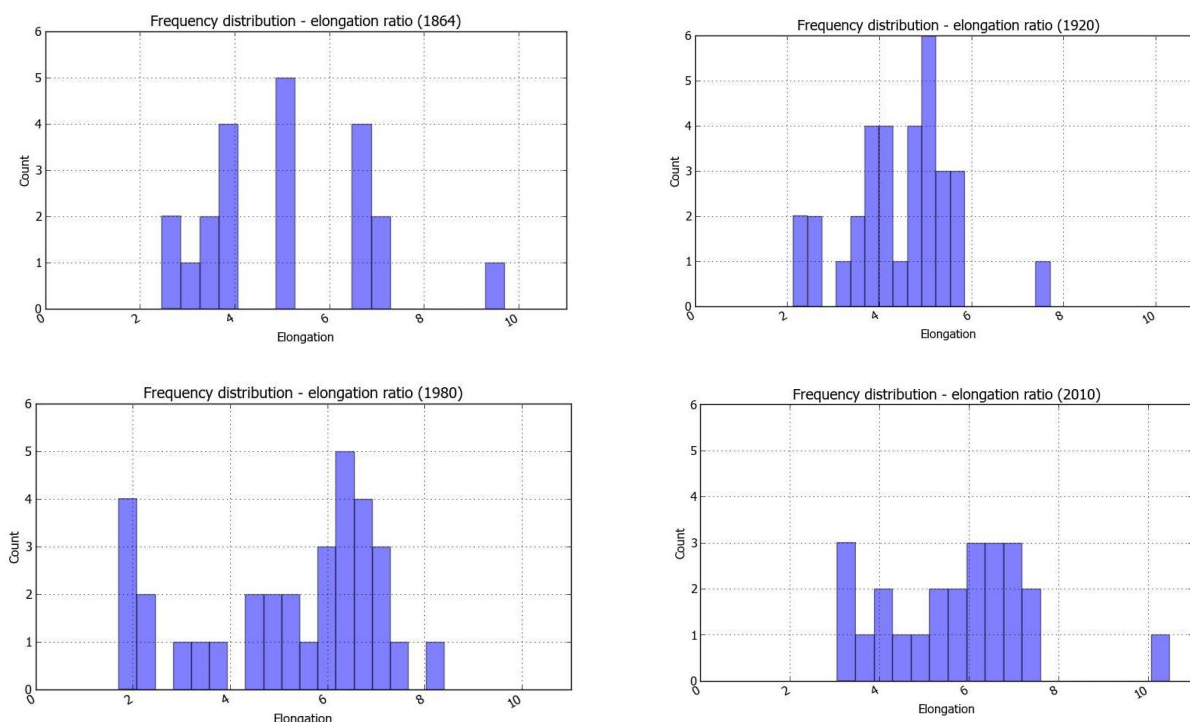


Fig. 5: Graphical representation of frequency distribution for elongation ratio (1864-2010)

Perimeter-Area Ratio

This parameter is, especially, used for the evaluation of habitats/distribution of species. It's important to know the values of this ratio for fluvial islets in the conditions that those landforms are a stopover and nesting place for many birds. Unfortunately, the measurement of this ratio doesn't

give standardized values, so, in specialized literature, the calculation of a shape index is also recommended, in which case, reporting is done to a perfect circle (Lang&Klung, 2006). In Fig. 6 it is represented the frequency distribution for perimeter-area ratio between 1864 and 2010.

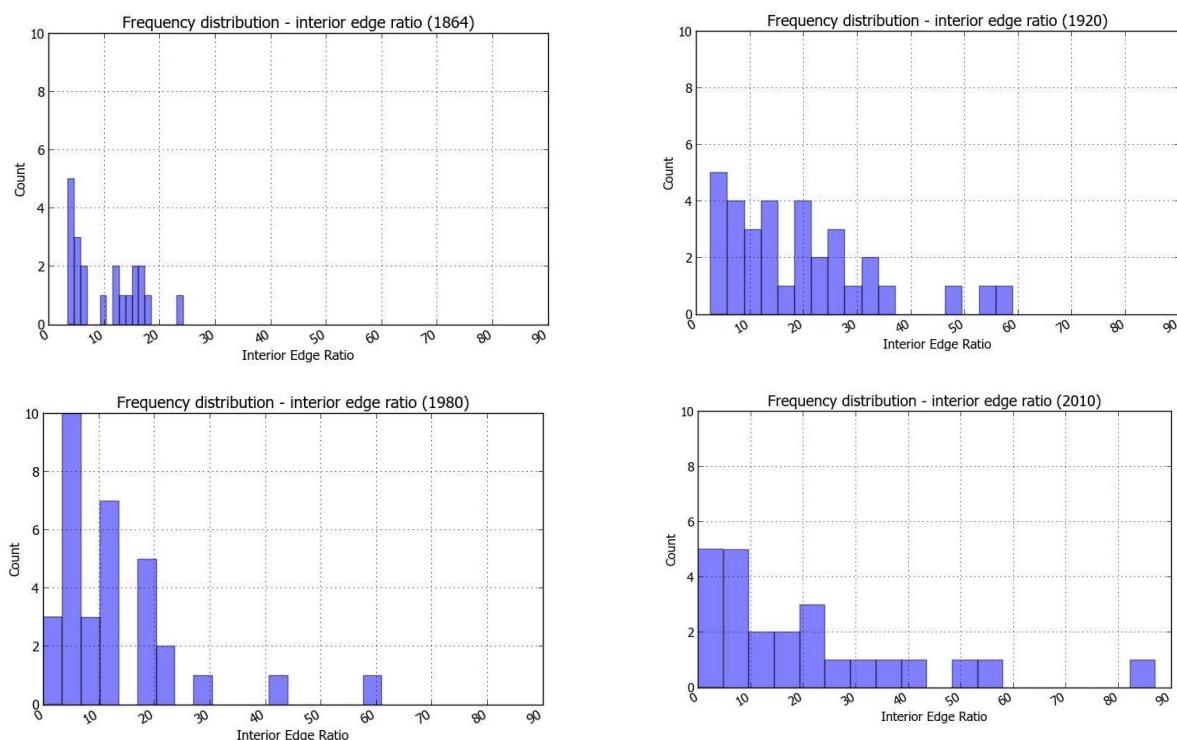


Fig. 6: Graphical representation of frequency distribution for perimeter-area ratio (1864-2010)

Shape Index

It is based on the ratio of perimeter to the square root of area. This index was proposed by Patton, in 1975, for quantifying habitat edge for species. If the polygon is a perfect circle its SI is 1

and as the aspect becomes more complex the SI increases (Comber, Birnie, Hodgson, 2013). For the years studied in this paper, values of the shape index for the river islets are greater than 1 (Fig. 7).

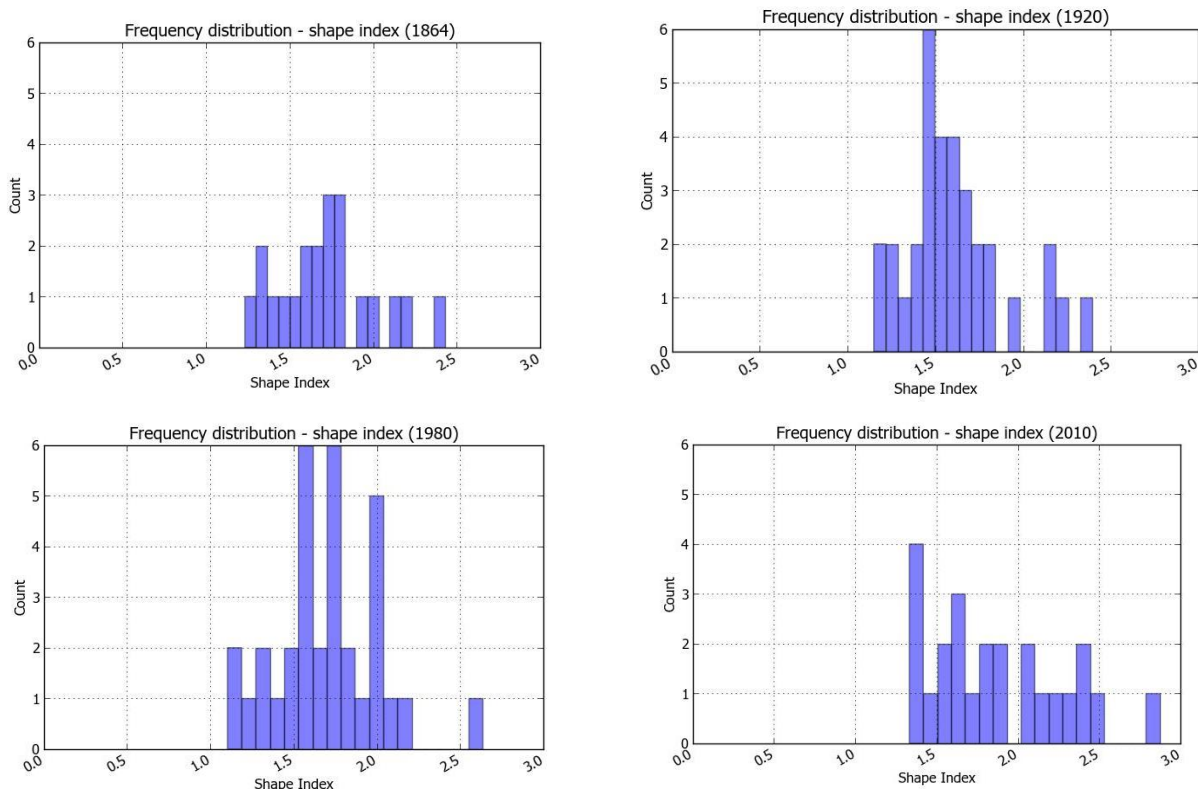


Fig. 7: Graphical representation of frequency distribution for shape index (1864-2010)

Furthermore, since 1980, the index shows values over 2.5 units. Taking into account the high values recorded for the rate of elongation and perimeter-area ratio, we can conclude that fluvial islets studied have an irregular and complex aspect.

Conclusion

During the period 1864-2010 (146 years), in the studied Danubian sector, the number of islets increased slightly between 1864-1920, after which their number remained constant. The total area of fluvial islets fluctuated, increasing and decreasing over time, but on the whole it grew from 21.19 sq.km to 27.96 sq.km. For a quantitative characterization of the morphology of fluvial islets we calculated some shape parameters. The values obtained for the elongation ratio, perimeter-area ratio and shape index highlights the general trend of those landforms to get a more complex and elongated aspect.

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The Assessment of Artificial Water Surfaces Regeneration in Satchinez Swamps Protected Area by Using Remote Sensing and In-situ Data

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Abstract

The Satchinez Swamps, a remnant of the swamps once specific for Banat Plain, is an ornithological reserve since 1942 and the habitat of many protected bird species. Draining works conducted in the seventies affected the reserve by decreasing the water surface area. Thirty-five years later, hydro-technical works aiming to restore the former aquatic surfaces within the buffer zone were conducted. Thus, in 2005 a water delivery canal from the discharge canal of Satchinez reservoir towards Balta Mare was built. The objective of this study is to assess the efficiency of the hydrological works carried out in 2005 by using temporal analysis of some normalized difference indexes derived from satellite images, in relation to precipitation data (recorded at Timișoara meteorological station) as an indicator for wetland restoration. We used geospatial data from different time periods: historical maps (1953, 1962 and 1984), orthophotos (1963, 1970, 2005 and 2012), oblique airphotos (2004) and 38 Landsat satellite scenes (1984-2015), two images per year, for the dry season respectively for the rainy season. We noticed a slight increase of the Normalized Difference Vegetation Index (NDVI) in Balta Mare and on the relict watercourse of Sicsău stream, which shows the expansion of reed and suggests an increase in soil moisture. During the dry season, for the period before the restoration works (1984 - 2004) there is a strong, very significant correlation between Normalized Difference Water Index (NDWI) and precipitations ($r = 0.7008$, $p = 0.0011$). After 2005, this correlation no longer occurs ($r = -0.1083$, $p < 0.05$), which demonstrates that precipitations are not the main water supply for Balta Mare anymore. For the 1984 - 2015 period, during rainy months the Modified Normalized Difference Water Index (MNDWI) indicate the presence of water in Balta Mare, but during the dry months, it demonstrates the lack of water which underlines the temporary character of this pond and confirms the field observations. We conclude that the restoration did not succeed in the rebuilding of the former water surfaces of Balta Mare, but has an effect in increasing the underground water level in this area followed by reed extension.

Keywords: *wetland restoration, air photo interpretation, NDVI, NDWI, MNDWI, Satchinez Swamps*

Rezumat. Evaluarea reconstituirii artificiale a suprafețelor acvatice din arealul protejat Mlaștinile de la Satchinez utilizând date de teledetecție și observații din teren

Mlaștinile de la Satchinez, rest al mlaștinilor specifice odinioară Câmpiei Banatului, au fost declarate rezervație ornitologică încă din anul 1942 și reprezintă habitatul multor specii de păsări protejate. Lucrările de desecare efectuate în anii șaptezeci au afectat rezervația ducând la scăderea suprafețelor acoperite de apă. După 35 de ani au fost realizate lucrări hidrotehnice cu scopul de a reconstitui vechile suprafețe acvatice din zona tampon. Astfel, în anul 2005, a fost săpat un canal de alimentare cu apă din canalul de descărcare al lacului Satchinez către Balta Mare. Obiectivul acestui studiu este de a evalua eficiența lucrărilor hidrologice efectuate în 2005 utilizând analiza temporală a unor indici normalizați de diferențiere derivați din imagini satelitare în corelație cu datele de precipitații (înregistrate la Stația Meteorologică Timișoara) ca indicator al gradului de reconstituire al mlaștinii. Am utilizat date geospațiale din diferite perioade de timp: hărți istorice (1953, 1962 și 1984), ortofotoplanuri (1963, 1970, 2005 și 2012), fotografii aeriene oblice (2004) precum și 38 de imagini satelitare Landsat (1984-2015), câte două imagini pentru fiecare an, una pentru intervalul ploios și cea de a doua pentru perioada secetoasă. Am observat o ușoară creștere a indicelui normalizat de diferențiere a vegetației (NDVI) în Balta Mare și pe cursul relict al pârâului Sicsău, fapt care se explică prin expansiunea stufului și care sugerează o creștere a umidității solului. În sezonul uscat, pentru perioada de dinaintea lucrărilor de restaurare (1984-2004), se înregistrează o corelare puternică, extrem de semnificativă, între indicele normalizat de diferențiere a umezelii (NDWI) și precipitații ($r = 0.7008$, $p = 0.0011$). După anul 2005 această corelare nu mai apare ($r = -0.1083$, $p < 0.05$), ceea ce demonstrează că precipitațiile nu mai reprezintă principala sursă de apă pentru Balta Mare. În perioada 1984-2015 în lunile ploioase indicele normalizat modificat de diferențiere a apei (MNDWI) indică prezența apei în Balta Mare, dar în lunile secetoase demonstrează lipsa acesteia, ceea ce evidențiază caracterul temporar al acestei bălți și confirmă astfel observațiile din teren. În concluzie, lucrările de restaurare nu au dus la refacerea fostelor suprafețe de apă din Balta Mare, dar au avut totuși un efect în creșterea nivelului apei freatice în acest areal, ceea ce a dus la extinderea stufului.

Cuvinte-cheie: *restaurarea mlaștinilor, aerofotointerpretare, NDVI, NDWI, MNDWI, mlaștinile de la Satchinez*

Introduction

The Satchinez Swamps ornithological reserve is located in Timis county, Romania, between Satchinez and Bărăteaz villages, in the floodplains of Ier river. The protected area currently includes, in addition to the actual reserve, located within Mărășești - Râtu Lișului area, a buffer zone located alongside Ier river, from east of Bărăteaz up to Râtu Mare, south-west of Satchinez (Fig. 1).

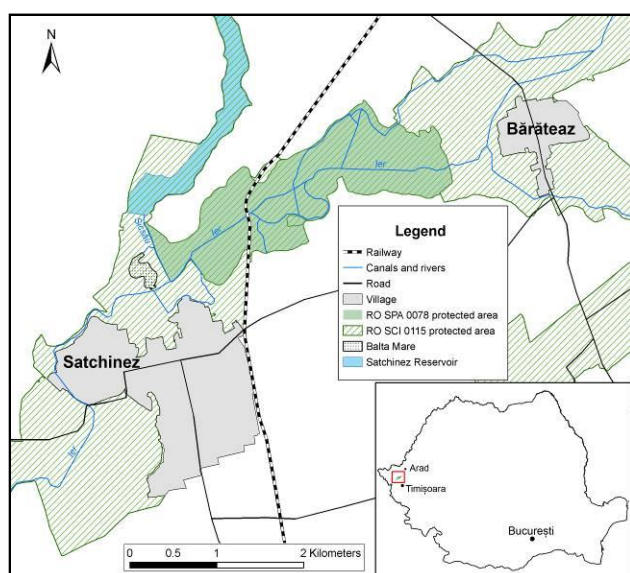


Fig. 1: Location of the study area

Satchinez Swamps was declared a natural reserve in 1942, covering approx. 200 hectares (Kiss, 1999). Nowadays, Satchinez Swamps Reserve is part of the Natura 2000 sites, representing RO SPA 0078 (268 hectares). The reserve and the buffer zone (1072 ha) are also included in the RO SCI 0115 protected area (2290 hectares) (Brînzan, 2013) (Fig. 1). The importance of these swamps comes from the fact that this is the habitat of several protected species of aquatic birds: *Egretta alba*, *Egretta garzetta*, *Ardea cinerea*, *Ardea purpurea*, *Nycticorax nycticorax*, *Plegadis falcinellus*, *Phalacrocorax pygmeus* etc. (Nadra, 1962, Kiss, 1999, Stănescu, 2005). The diversity of ornithofauna is demonstrated by the large number of bird species (167 bird species) identified between 2003 - 2005, which means more than half of the Romanian avian fauna (Stănescu, 2005). Among them, *Crex crex*, *Aythya nyroca* and *Falco vespertinus* are globally protected species (Brînzan, 2013).

Nevertheless, between 1960 and 1970 several draining works were conducted, in order to convert some land areas into agricultural use. Consequently, the protected area decreased and the water surface area was also reduced as a result of the draining works, bearing an impact on avian fauna and natural habitats (Kiss, 1999, Stănescu, 2005). During the

1963-2004 interval, the water surface area decreased by approximately 3 hectares, while the reed (*Phragmites australis*) covered surface grew from 220 hectares to 284.5 hectares, revealing the clogging tendency of the swamp (Török-Oance and Török-Oance, 2005, 2008). Hydro-technical works were also carried out, in order to supplement the water intake of the central part of the Reserve, works which were abandoned after 1989. The consequence was the significant decrease of water level in the Reserve during the immediately following period (Stănescu, 2005). Between 1999 and 2002, under LIFE 99/NAT/RO/006394 project, the current hydrotechnical system was rehabilitated following unclogging works to the reserve's water supply canal and repair works of the dams of the hydrotechnical system, aiming to restore and preserve the reserve habitats (Stănescu, 2005). The following project, LIFE 02/NAT/RO/8573 (2002-2005), included also hydro-technical works in the Balta Mare area. Thus, a water supply canal was dugged from Sicsau canal towards Balta Mare in order to restore this former aquatic surface located in buffer zone. The buffer zone is important because it represents, due to its water surfaces, a feeding place for birds, and also for lowering the anthropic impact over the reserve itself. The anthropic impact over the reserve is high and diverse: agricultural activities, hydrotechnical work, cutting and setting fire to reed, felling trees, fishing, hunting, transportation (Török-Oance and Török-Oance, 2005).

Knowing the current status of the swamp, as well as the changes that have occurred is essential for its preservation and for choosing the proper decisions necessary for a sustainable management. Considering it is a remnant of the swamps once specific for Banat Plains (Stănescu, 2005), and that it was significantly and repeatedly transformed by hydrotechnical works, we ask ourselves the legitimate question if and how much this area has been rehabilitated after the reconstruction works carried out in 2005.

Generally, the main purpose of the restoration works of the swamps is to restore the hydrologic drainage system and the vegetation to its initial state (Melesse et al., 2007), which would enable the restoration of the ecosystems. Monitoring the achieved outcomes is necessary to determine the efficiency of the intervention (Klemas, 2013). Unfortunately, the monitoring has not been accomplished anymore for the Satchinez Swamps.

The objective of this study is to assess if the hydrological works carried out in 2005 in the buffer zone for the purpose of rebuilding the former surfaces occupied by water (Balta Mare area) - eliminated by the draining works carried out in the seventies - had the expected effect. Since this is not

apparent in the field, as Balta Mare is, just like in the previous years, temporary, we used the remote sensing data to reach an objective conclusion. The methodology we propose uses temporal analysis of normalized difference indexes for vegetation, moisture and water, derived from satellite images, in relation to precipitation data as an indicator for wetland restoration. So, we started from the premises that within Balta Mare area the values of the moisture indexes should be more dependent on the amount of precipitation in the years preceding the restoration than after the building of the water delivery canal from the discharge canal of Satchinez reservoir towards Balta Mare. Due to the random additional water intake, other than from precipitations, this correlation should be weaker after 2005.

Materials and methods

Data

In order to perform the temporal analysis of the studied area, historical maps from different time periods were used. The maps are drawn at detailed scale to enable such analysis. Thus, there were used topographic maps, at scale 1:20.000 (Mănăştur sheet) from 1953 and at 1:25.000 (Satchinez sheet) from 1962, 1984 respectively.

In order to perform a more objective analysis, orthophotos were used (Table 1). There is no detailed information regarding the image acquisition date, only the year in which the aerial photography was conducted.

Since there are no more recent orthophotos, for 2016 we used for visual analysis a very high spatial resolution satellite image (VHR), acquired on the 21st April (source: Google Earth). The image is comparable, in terms of spatial resolution, with aerial photographs.

Table 1: The orthophotos used in this paper

Date	Scale/Spatial resolution	Film type/Bands	Format	Source	Observations
1963	1:5000	Panchromatic film	Hard copy	IGFCOT*	The orthophoto captures the reserve area before the anthropic intervention.
1973	1:10000	Panchromatic film	Hard copy	IGFCOT*	The orthophoto captures the moment immediately following the hydrotechnical works performed for draining and for building the Satchinez reservoir.
2005	1:5000/0.5m	Red, Green, Blue	GeoTiff	ANCPI**	The orthophoto captures the hydrotechnical works for restoring Balta Mare area, under LIFE 02/NAT/RO/8573 project.
2012	1:5000/0.5m	Red, Green, Blue	GeoTiff	ANCPI**	The most recent colour orthophoto available for the study area.
2012	1:5000/0.5m	NIR, Red, Green	GeoTiff	DTM***	The most recent colour infrared orthophoto available for the area on study

* Institute of Geodesy, Photogrammetry, Cartography, and Territorial Planning

** National Agency for Cadastre and Land Registration

*** Military Topographic Directorate

The Landsat program, started in 1972, is the longest-running enterprise for monitoring the earth surface with satellite imagery. Landsat 5 started image acquisition in 1984. These are compatible, in terms of spectral and spatial resolution, with the images collected by more recent satellites, Landsat 7 and Landsat 8 (<http://landsat.gsfc.nasa.gov/>). So, in order to assess the efficiency of the hydrotechnical works carried out to restore Balta Mare area, we used 38 Landsat satellite scenes (path 185 and row 028) acquired between 1984-2015 by different sensors: Thematic Mapper (TM), Enhanced

Thematic Mapper Plus (ETM+) and Operational Land Imager (OLI) (images courtesy of U.S. Geological Survey). All the scenes used are georeferenced and terrain corrected (Level 1T) and the cloud coverage level for the study area was 0%. Only for four years, there were no cloud-free images in rainy months (May or June) (Fig. 2).

Two scenes were used for almost every year, one from May or June, when the maximum amount of precipitations is recorded, and the second from August or September, period characterized by a significant decrease in the amount of precipitations,

which leads to the drying up of temporary ponds. The spectral bands used in this study to calculate the normalized difference indexes are: blue (BLUE), green (GREEN), red (RED), near infrared (NIR) and

shortwave infrared 1 (SWIR 1). All bands have the same spatial resolution (30 m) and were used to calculate some normalized difference indexes for vegetation, moisture and water.

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* = no cloud-free images

Fig. 2: Landsat scenes used in this analysis and their acquisition date

Photographs taken during 2004, 2005 and 2016 field campaigns, as well as aerial photographs from 2014 have also been used. The aerial photographs were taken by Dan Stănescu and Marcel Török – Oance, who took two flights with a motor-glider, at approximately 300 m altitude above the reserve on 4th May 2004 (Török - Oance and Török - Oance, 2004). At that moment, the most recent aerial photogram was dated back to 1973, so these aerial photos represent the only objective geo-spatial information regarding the status of the protected area just one year before the beginning of the restoration work in buffer zone. Out of these photographs, only those capturing Balta Mare area were selected for comparison.

The monthly average precipitation values for the analysed period (1984 - 2015) recorded at Timisoara meteorological station was used. Given the short distance to the protected area, of only 26 km in straight line, and the existence of a plain landform, characterized by morphometric and morphological homogeneity, we considered that the data recorded at this meteorological station were relevant for the study area. We considered that soil and vegetation moisture, as reflected by the normalized difference indexes values, are determined mostly by the amount of precipitations on longer period of time, including the water resulting from snow melting, than monthly amount of precipitations. For example, the time lag between the response of plants to increasing of moisture could be until two months (Richard and Pocard, 1998). Thus, we considered more suitable for this analysis to use the amount of precipitations in that year until the acquisition date of the satellite image instead of monthly precipitation values.

Methods

The printed orthophotos dating back to 1963 and 1972 were scanned and georeferenced in the Stereo 1970 projection system (Török - Oance and Török -

Oance, 2004). The spatial resolution obtained is 1 m, with a Root Mean Square Error of 0.79.

Since the normalized difference indexes derived from the satellite images acquired in different years were to be compared against one another, in order to observe the occurred changes, it was necessary to perform radiometric corrections of the images (Ko et al., 2015). Consequently, the atmospheric correction of the images was performed, and each band was calibrated in terms of radiance to the superior level of the atmosphere (top of atmosphere radiance) using QUAC tool (Envi software).

Since the analysed area is much smaller than a Landsat scene, we extracted only the area under study from each scene, according to the boundaries of the protected area.

The following differentiating normalized indexes were used in this study: Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI), and Modified Normalized Difference Water Index (MNDWI).

NDVI (Rouse et al., 1974) is used to estimate the distribution and density of green vegetation per image pixel. Its values are ranging from -1 to 1, the positive values represent green vegetation, while the negatives values represent water bodies.

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

NDWI illustrates the water content of the vegetation and soil (Gao, 1996, Wilson and Sader, 2002) and assess the hydrous potential of vegetation and soils. NDWI is an efficient and accurate index for wetland detection (Ashraf and Nawaz, 2015). The value of NDWI for the dry vegetation spectrum is negative and for the green vegetation spectrum is positive. Water has also positive value. It is calculated using the infrared spectral band (NIR) and the shortwave infrared (SWIR 1), according to the formula:

$$NDWI = (NIR - SWIR 1)/(NIR + SWIR 1)$$

MNDWI (Xu, 2006), was built for aquatic surfaces detection, and reduce the similarity with built areas, vegetation or soil. It uses the green spectral band (GREEN) and the shortwave infrared (SWIR 1), according to the formula:

$$MNDWI = (GREEN - SWIR 1)/(GREEN + SWIR 1)$$

The MNDWI is an effective index for detecting open water and wetland environments (Jones, 2015, Sun et al., 2012, Thomas et al., 2015).

The visual exploration of cartographic materials and aerial photographs integrated in GIS (ESRI ArcGIS 10.1 software), from different periods of time, enabled the analysis of the evolution of the study area and the evaluation of changes in wetland ecosystem (Török-Oance and Török - Oance, 2004, Cserhalmi et al., 2011). The ponds, rivers and canals, the alterations of which were tracked over time in order to observe the impact of reconstruction works, were extracted by digitization.

For each and every year, the values of the normalized difference indexes were extracted as ASCII files from Balta Mare, which were later on statistically analysed in InStat software. The statistical analysis of the data focused on extracting the descriptive statistical variables, variation analysis and the analysis of the relationship between variables. The interpretation of the correlation coefficients was as follows: $r > 0.7$ = strong correlation, $r = 0.4-0.7$ moderate correlation, $r < 0.4$ = weak correlation (Holmes et al., 2014). For statistical tests, the following interpretation of two-tail P values was used: $P < 0.05$ = significant, $P < 0.01$ = very significant, $P < 0.001$ = extremely significant, $P > 0.05$ = not significant (Marzilier, 1990).

Since NDWI and NDVI are often related with the amount of precipitations (Richard and Poccard, 1998, Roerink et al., 2003, Quinn and Ephstein, 2015), a change detection analysis was conducted between the normalized indexes for two periods during which the same amount of precipitation was recorded: 2003 (339.5 mm) and 2009 (348.8 mm). The first moment was selected before digging the canal (14th August 2003 Landsat scene), and the second moment was chosen after 2005, when the canal was already built (15th August 2009 Landsat scene). These moments are to be called T1 and T2 hereinafter.

Field mappings of the interest areas were conducted and photographs were taken for the sectors in which the swamp reconstitution was attempted. In order to reveal the occurred changes,

the photographs were compared to photographs dating back 10-12 years ago (Török - Oance and Török - Oance, 2004).

Results and discussions

Wetland restoration is a new field of research which is developing rapidly. The restoration can be expensive and time consuming. Given the poor understanding of the complex processes that determine the character of a wetland, the restoration of the original conditions is often unsuccessful (Klemaš, 2013).

Considering that hydrology is the most important element in the creation and maintenance of wetlands, water management is the key in restoring wetlands (Acreman et al., 2007). Wetland systems are vulnerable to changes in water intake, both in terms of quantity and quality (Mitsch and Gosselink, 1993).

The main purpose of the analysis of historic mapping and old orthophotos was to determine a geo-spatial reference point representing the state of the reserve prior to its transformation through extensive hydrotechnical works. This is important because the current study attempts to determine the efficacy of the ecological restoration works of the protected area and this cannot be achieved without such a spatial-temporal benchmark.

All historic maps indicate the presence, of a wetland area north of Satchinez, covered with reed and ponds (Fig. 3 and Fig. 4). The largest surface in this area is occupied by Balta Mare (approximately 6 hectares). This is one of the areas transformed by the draining works carried out in the seventies and which was to be restored by hydrotechnical works in 2005. The 1953 and 1984 maps record this area as lake or pond, while the 1962 topographic map records Balta Mare as a hardly accessible swamp.

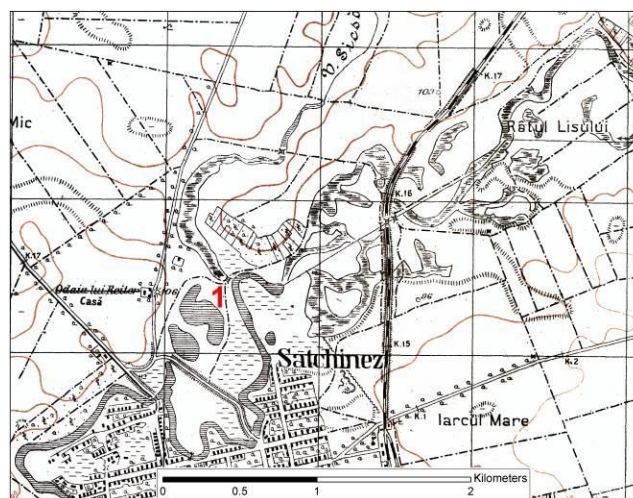


Fig. 3: Balta Mare (1) drawn on 1953 topographic maps, scale 1:20.000 (Mănaștur sheet)

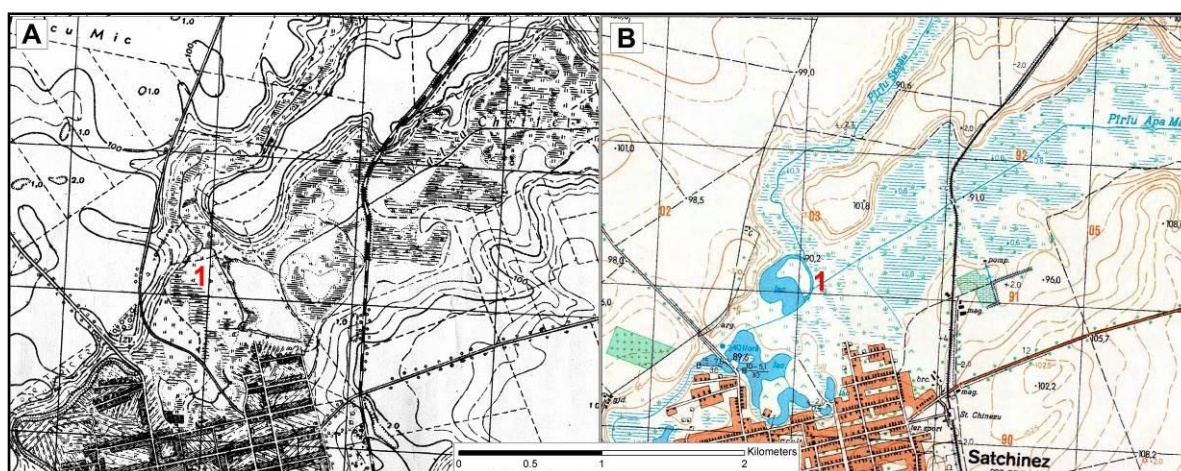


Fig. 4: Balta Mare (1) plotted on 1962 topographical map (A) as hardly accessible swamp and plotted on 1984 topographical map (B) as pond (scale 1:25000)

We can also notice a lack of consistency from one map to another when representing the other ponds bordering Satchinez village, both in terms of size and shape. The hydrographic network is not plotted on the 1953 map, but it is recorded on the other two maps. On the 1962 map, it is clearly visible that Balta Mare is supplied by Sicsău stream. The 1984 map, drawn after the draining works, reveals the changes in the hydrographic network occurred through the construction of draining canals, but, in our opinion, this map contains a few errors. Thus, according to this map, the Ier canal feeds Balta Mare but, in reality, the canal passes south of it, as it was built precisely for draining this pond. Satchinez reservoir and the sewerage works downstream of it are not recorded either.

The 1963 and 1973 orthophotos capture

objectively the situation prior to the draining works, and the one immediately following their completion, respectively (Fig. 5). The 1963 orthophoto captures a moment which can be considered without any doubt the reference point for this analysis. No anthropic intervention over the hydrological network in the protected area is visible on the orthophoto. The valley of Sicsău river meanders extensively and is bordered by reeds and swamps that make the view of the watercourse difficult or even impossible in some places. However, Balta Mare has a clear outline, is surrounded by pastures and is fed with water in the north from Sicsău stream. It is mainly covered by reed, with small water pools. One can also notice the canal which ensures the discharge of water from Balta Mare back into the main watercourse of Sicsău.

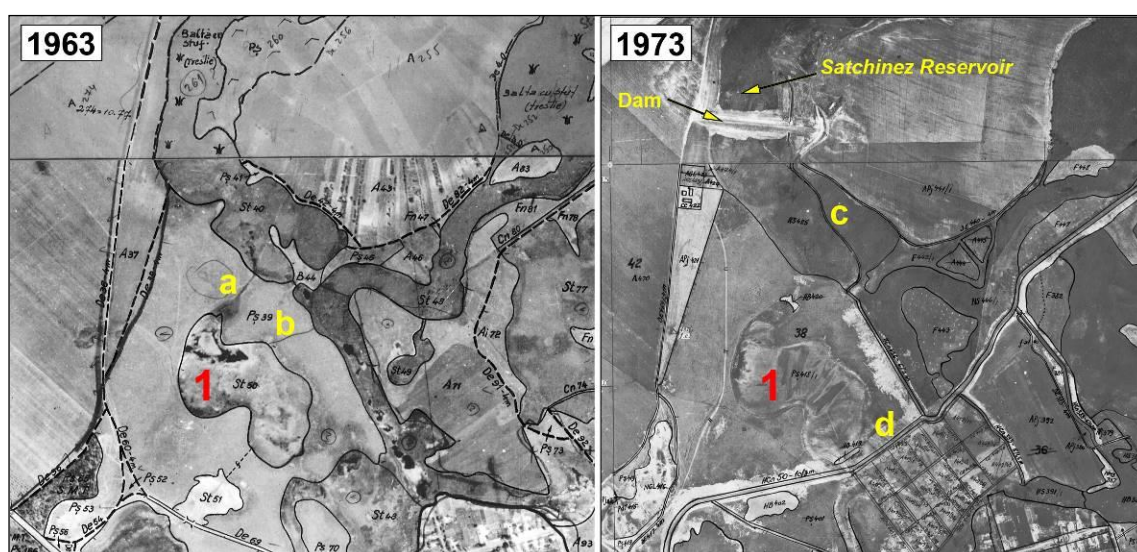


Fig. 5: The Satchinez Swamps Reserve and Balta Mare area (1) prior to the draining works (1963 orthophoto) and after their completion (1973 orthophoto). a and b, watercourses linking Balta Mare and Sicsău stream; c, Sicsău draining canal; d, Ier draining canal

The orthophoto taken in 1973 illustrates the main changes of the hydrographic network from the protected area, due to the hydrotechnical works conducted in the area: the construction of the dam and the reservoir on Sicsău valley, north of Balta Mare, and the transformation of the natural watercourses of Ier and Sicsău by making draining canals with depths of 3 m, 2 m, respectively. One can also notice, south of Balta Mare, the presence of ponds which would disappear in the following years due to the descent of ground water level dictated by building the draining canals. Balta Mare is listed as pasture, but it is easily recognisable due to the shape of the lake basin, shape which is maintained. The image texture suggests that it was artificially submitted under this type of land usage, since its wet meadow character is obvious (Fig. 5).

Since there are no aerial photographs for the

period 1973 - 2005, in order to capture the state of the reserve before the start of ecological reconstruction we used aerial, oblique photographs, shot in May 2004. Thus, the aerial photograph (Fig. 6) illustrates Balta Mare area one year before the start of the reconstruction works within this area. The lake basin is easily recognisable, as its shape is identical to the one recorded on the old orthophotos. Both May and April of that year had a higher volume of precipitations than the multi-year average of those months. This explains the water pools in the centre of the area, which confers this area its temporary, very shallow pond character. It can also be noticed the low coverage with reed of the land surrounding the pond and of the former Sicsău watercourse and its reduced development when compared to the protected area.

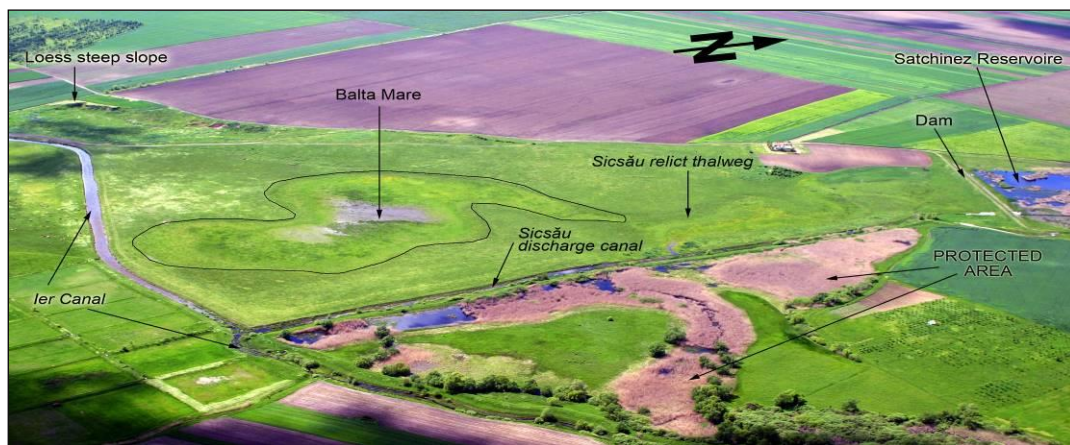


Fig. 6: The oblique aerial photograph of the Balta Mare area shot in 4th May 2004 from a motor-glider, at approximately 300 m altitude above the reserve

The 2005 orthophoto captures the state of the reserve 30 years after the draining works. Balta Mare retains its shape and character of wetland pasture. According to the findings on site, it operates as a temporary pond, with shallow water, only during the rainy spring months (Fig. 7). The construction of the water delivery canal (Fig. 8) from the discharge canal of Satchinez reservoir towards Balta Mare, on the Sicsău relict watercourse and the

dam downstream (Fig. 6) which is designed to control the water flow directed towards the former pond can be seen on orthophoto. Some areas are impacted by the deposits of excavated materials as a result of digging the canal and by the construction of the road for accessing the work site, a road which is parallel with Sicsău discharge canal, on its right bank.



Fig. 7: Balta Mare during the rainy season (March 2004) and the dry season (October 2016). The reed expansion in the central part of the lake basin is obvious in the picture from 2016

The 2012 orthophotos, in natural and near-infrared colours (Fig. 9), reveal the regrowth of vegetation in the sectors impacted by the works conducted in 2005. Balta Mare supply canal has a slightly irregular outline, due to the appearance of paludous vegetation and the bank erosion caused in some sectors by the cattle coming to drink water in that place. Balta Mare is covered with water in its central part, which can be easily visible on the NIR image. We believe this fact is not due in particular to the water drained towards Balta Mare through the canal built in 2005, but to the rainy period during which the image was acquired. Although we do not have the exact date of image acquisition, we can estimate it with enough certainty because the agricultural lots south of Ier canal are flooded, which happens only during the periods with heavy rainfalls. There can also be noticed a slight expansion of the area covered by reed adjacent to the dam and along the relict watercourse of Sicsău river.



Fig. 8: The hydrotechnical works and construction of the water delivery canal in 12th April 2005

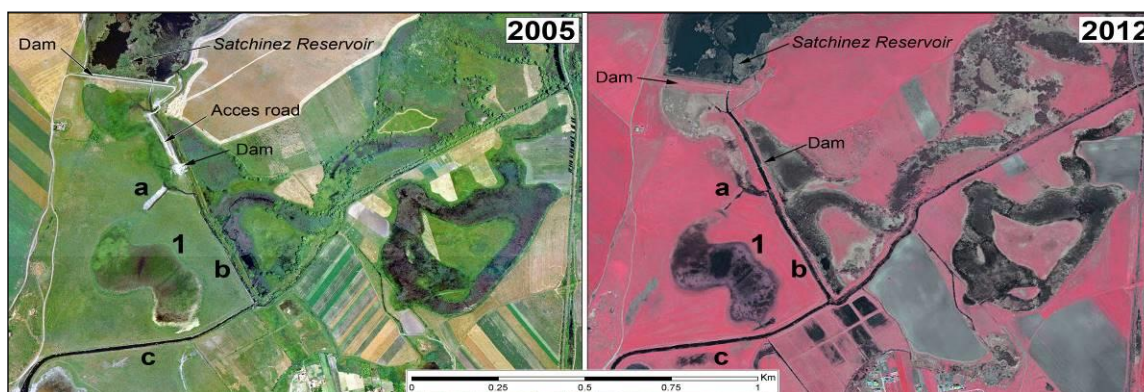


Fig. 9: The 2005 and 2012 orthophotos. 1, Balta Mare; a, the water supply canal built in 2005; b, Sicsău canal; c, Ier canal

The very high resolution satellite image, available on GoogleEarth, is the most recent image and captures the current state of the protected area. It illustrates a moment at the end of September, usually a month with low precipitations. There is no more water in Balta Mare, which clearly

demonstrates its temporary character, despite the restoration works. It can also be noticed the advanced clogging stage of the water supply canal in 2016 (Fig. 10), a fact which we also noticed on site (Fig. 11).



Fig. 10: Advanced clogging stage of the water supply canal (a) in 2016 (source Google Earth) compared with 2012 color orthophoto. 1, Balta Mare

The area covered with reed expanded noticeably compared with 2012, but the expanded reed remained at a low height compared to the reed in reserve.



Fig. 11: Advanced clogging of the water supply canal built in 2005. The banks are eroded or covered with reed (October 2016)

On all mapping and orthographic materials under analysis, Balta Mare is clearly outlined, having almost the same size and shape, both before and after the draining works. This is due to the existence of a depressionary landform, highly visible in the land surface, approx. 1.5 m deep in the west, at the base of the slight slope of Iarcu Mic hill. In this area, Balta Mare is clearly outlined from the hill slope by a steep slope sector. In our opinion, the lake basin of Balta Mare is created by suffosion and compaction of loess-like deposits forming the geological sub-layer of the study area. Such loess sinkholes were already noticed in this area (Morariu, 1946). The lake basin was also shaped by river erosion, due to its location in the former watercourse of Sicsău river (according to the 1963 orthophoto) and also by its relatively regular, meandered shape. The existence of this negative, concave landform explains why, in spite of the efforts made for draining the area, Balta Mare could never be transformed into a pasture, and retained its character of wetland meadow and, for several month per year, temporary pond (Fig. 7).

NDVI shows great variability through the years, both for Balta Mare and the entire protected area. The ANOVA analysis for the period 1984 - 2015 shows that NDVI values are significantly and extremely significantly different from one year to another, with a few exceptions. The correlation between NDVI and the volume of precipitations is statistically significant ($p=0.0237$), but moderate

($r=0.6789$), due to the presence of swamp-specific vegetation on large surfaces.

The comparative analysis between T1 and T2, performed by the image differencing method, reveals a slight increase of the NDVI value in Balta Mare area and on the relict watercourse of Sicsău stream, downstream of the dam, during August 2009 (Fig. 12). This fact is explained by the expansion of reed, as confirmed by the findings on site (Fig. 7 and Fig. 13) and suggests an increase in soil moisture. It has been demonstrated that there is a strong spatial autocorrelation between soil moisture and the density of reed and also that the increase in soil moisture enhances the reed growth (Mamat et al, 2016). The relation between vegetation and groundwater level could be an indicator of wetland restoration (Kopeć et al., 2013).

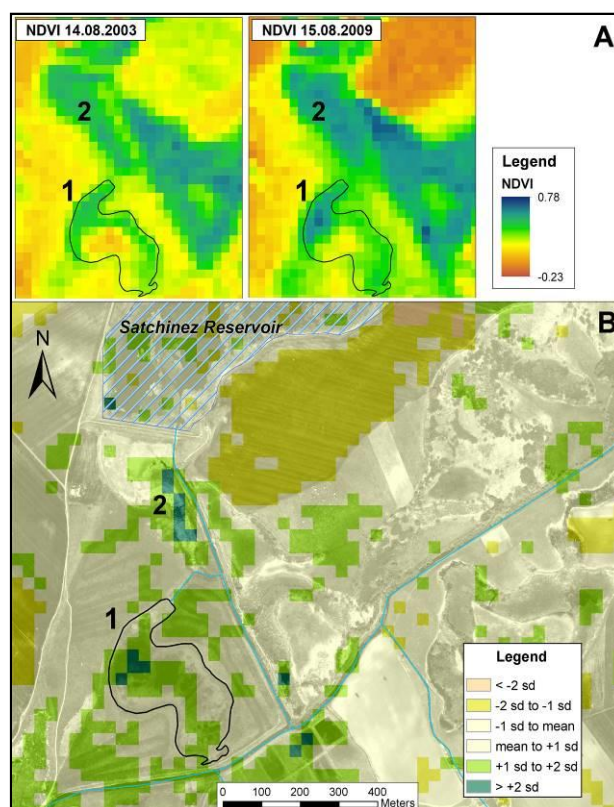


Fig. 12: NDVI comparison between T1 and T2 (A) and NDVI standardized difference image for the same interval (B). The values between +1 and +2 standard deviation show medium NDVI increase and values above +2 standard deviation indicates high NDVI increase. 1, Balta Mare; 2, the relict watercourse of Sicsău stream

NDWI analysis for Balta Mare reveals a moderate, but significant correlation with the volume of precipitations for the entire period under

analysis ($r = 0.4724$, $p = 0.0478$). The values of the correlation coefficient for the period before conducting the restoration works (1984 - 2004) show there is a strong, very significant correlation between this index and the precipitations ($r = 0.7008$, $p = 0.0011$) (Fig. 14 A). However, during

the period between 2005 and 2015, this correlation no longer occurs ($r = -0.1083$, $p < 0.05$) (Fig. 14 B), which demonstrates that precipitations no longer represent the only source of water supply for Balta Mare.

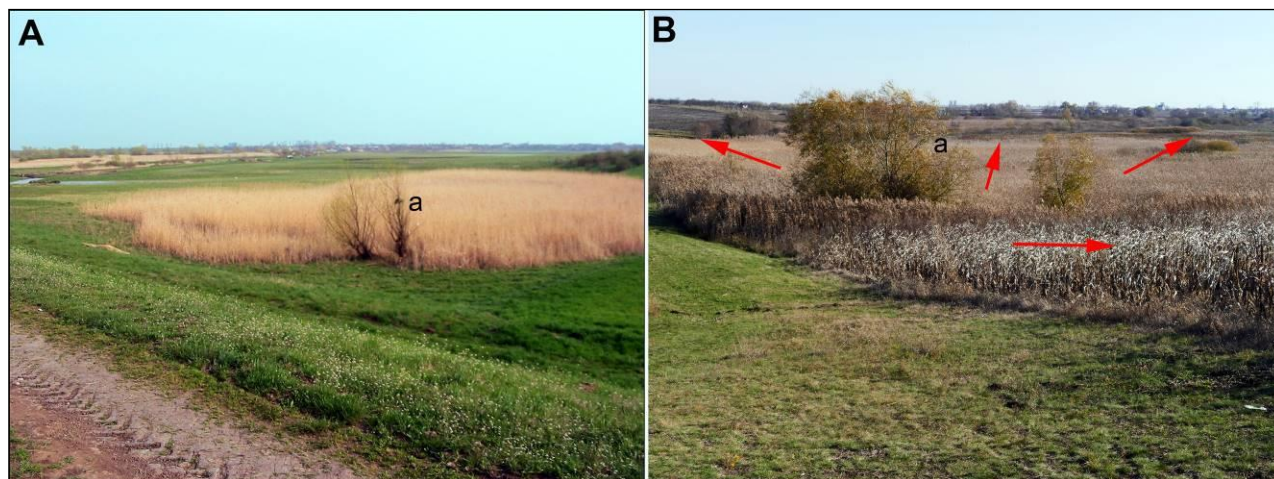


Fig. 13: Reed occurrence in 2004 (A) and in 2016 (B) at the relict watercourse of Sicsău stream south of Stachinez reservoir. The red arrows show the reed expansion directions. a, tree as a reference point

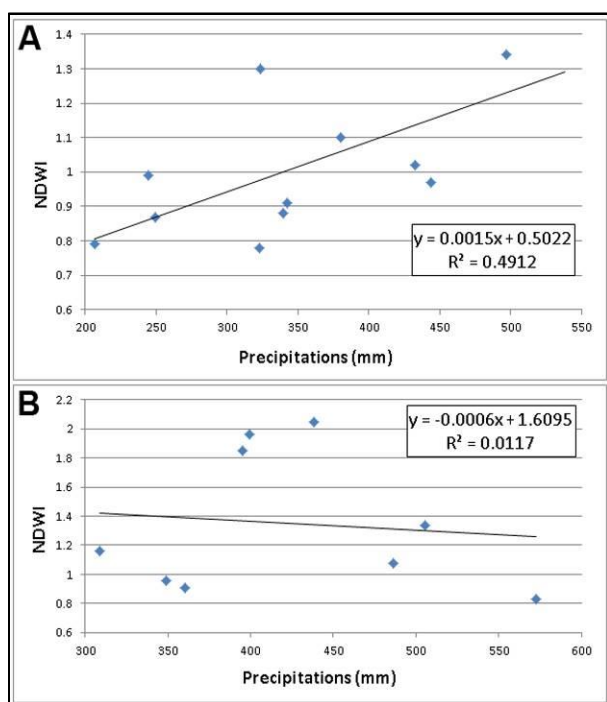


Fig. 14: Linear regressions and coefficients of determination between precipitations and NDWI in 1984 - 2004 interval (A) and after the completion of hydrotechnical works (B), in 2005 - 2015 interval

Even throughout drier years, such as 2011, the NDWI value was quite high, and suggests an increase of the groundwater table level. A high groundwater table level is a key factor for wetlands (Mitsch and Gosselink, 1993), so we can consider

the restoration works had a beneficial effect on preserving the wetland character of Balta Mare even in dry months.

Comparing the NDWI values between T1 and T2, one can also notice that average value in 2009 was higher than the one in 2003. Also, the comparison between the two sets of values using the Wilcoxon matched pair test show that these are extremely different ($p < 0.0001$). Even if there is a significant increase in NDWI values in Balta Mare area after 2005, however, these are not very high which reveals still low vegetation water content.

MNDWI was used to detect the presence of water in Balta Mare. During all the rainiest months (May or June Landsat scenes), one can observe the presence of water in Balta Mare area demonstrated by slightly positive values of MNDWI. No significant differences are observed after 2005. The MNDWI values extracted from all August and September Landsat scenes are negative, which demonstrates the lack of water. The situation is also similar after the construction of the water supply canal for Balta Mare. This clearly shows that the restoration works of the area did not lead to the recovery of Balta Mare. Despite the construction of the water supply canal, it dries up during dry months. The comparative analysis between T1 and T2 shows a slight decrease in MNDWI values, which can be explained by the advancement of reed (Fig. 7).

Conclusion

The type and the genesis of the lake basin of Balta Mare explain why this is the only pond in this area which retains its shape and size, both before and after the draining works. The loess sinkhole is recorded in all the cartographic documents and aerial photographs under analysis, ever since 1952. The presence of this depressionary landform also explains the preservation of the character of wetland meadow for this area even after the draining works, being artificially submitted as pasture in the cadastral plans, during the communist period.

The findings on site suggest that the restoration works do not seem to succeed in the rebuilding of the former water surfaces in Balta Mare. However, this method, namely the analysis of normalized differentiating indexes in relation with the precipitations is able to reveal some transformations of the Balta Mare area, as a consequence of the restoration works, transformations which are not easily observed in the field.

The MNDWI analysis underlines very clearly the temporary pond character of this area and confirms the field observations. During the 1984 – 2015 period, during the dry months (August Landsat scenes) MNDWI values indicate the total absence of water in Balta Mare.

NDWI is strongly correlated with the amount of precipitations until 2005. Afterwards, the values of this index are no longer correlated with the precipitations, which demonstrate that the supplementary induced water flowing into Balta Mare through the water supply canal has the effect of transforming this area by increasing the soil and vegetation moisture. This suggests the possibility of increasing the underground water level in this area, a fact which is also emphasized by the reed extension both in Balta Mare and along the relict watercourse of Sicsău river.

Balta Mare preserves its temporary character acquired after the draining works from the seventies, despite the efforts for restoring the former aquatic surfaces. An important factor which explains this fact is the presence of two draining canals in the immediate vicinity, significantly lower compared to the pond: Ier canal, just 20 m away to the south, and Sicsău, approx. 100 m eastwards. They continue to contribute to lowering the ground water level so that in dry seasons the water intake through the water supply canal built in 2005 is not sufficient to help water retention in Balta Mare.

We conclude that the restoration did not succeed in the rebuilding of the former water surfaces of Balta Mare, but it has an effect in increasing the underground water level in this area followed by reed extension.

Author contribution

Marcel TÖRÖK – OANCE: Concept of the paper, responsible for the Materials and methods, Results and discussion, and Conclusion sections, remote sensing data processing and air photo interpretation, cartographic design, in-situ observation.

Rodica TÖRÖK – OANCE: Research design, responsible for Abstract and Introduction sections, contributions to Results and discussion and Conclusion sections, statistical analyses and in-situ observation.

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Faunistic Study of the Tsibar Danube Island

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Abstract

Tsibar Island is situated on the Bulgarian part of the Danube River, at 680 m of the Bulgarian and about 100 of the Romanian coast from 716 to 719 km along the river, with an area of 1.3 km². The territory is covered mainly by riparian woodland. Because of its European importance to the protection of rare and threatened habitats, plants and animals, including birds, the island falls within the borders of proposed Natura 2000 sites under both the Birds and the Habitats Directives.

Part of the island is placed under strict protection as a managed reserve "Ibisha". In 1997 the territory was designated as an Important Bird Area by BirdLife International. In 2002 the reserve has been declared as a Ramsar site according to the international convention for the conservation of wetlands. Tsibar Island is of international importance defined by one of the largest mixed colony of herons and cormorants in Bulgaria. It is a site of global importance for the nesting Pygmy Cormorant (*Phalacrocorax pygmeus*) and White-tailed Eagle (*Haliaeetus albicilla*) and one of the most important sites in Bulgaria for the nesting of the Night Heron (*Nycticorax nycticorax*), Squacco Heron (*Ardeola ralloides*) and Spoonbill (*Platalea leucorodia*). There have been identified more than 100 animal species: 42 terrestrial and 16 aquatic invertebrates, 5 fish species, 1 amphibian and 1 reptile species, 30 birds (including 22 breeding), 16 mammalian species (including 8 species of bats). Ascertained are the Medicinal leech (*Hirudo verbana*), which is a rare species at the European level, endangered Thick-shelled river mussel (*Unio crassus*), protected fish Asp (*Leuciscus aspius*) and Great raft spider (*Dolomedes plantarius*), included in the Red Data Book of Bulgaria in the category "extinct". A management plan for Ibisha Menaged Reserve was developed in 2015.

Keywords: fauna, Ibisha reserve, Tsibar Island, Ibisha Ramsar Site

Rezumat.

Studiul faunistic al Insulei dunărene Tsibar

Insula Tsibar este situată în partea bulgărească a fluviului Dunărea, la 680 m de malul bulgăresc și aproximativ 100 m de malul românesc, între km fluviali 716 și 719, având o suprafață de 1,3 kmp. Teritoriul este acoperit în general de păduri ripariene. Datorită importanței sale europene pentru protecția unor habitate rare și amenințate, plante și animale, inclusiv păsări, insula se încadrează siturilor Natura 2000, atât în cadrul Directivei Păsări, cât și a Directivei Habitate.

Parte din suprafața insulei este sub protecție strictă, fiind inclusă rezervației *Ibisha*. În anul 1997, teritoriul a fost declarat ca Arie Avifaunistică Importantă de către organizația BirdLife International, iar în anul 2002 sit Ramsar, conform convenției internaționale pentru conservarea zonelor umede. Insula Tsibar prezintă importanță națională ca urmare a prezenței uneia dintre cele mai mari colonii mixte de stârci și cormorani din Bulgaria. Este un loc de importanță globală pentru cuibărirea cormoranului pitic (*Phalacrocorax pygmeus*) și a șoimului codalb (*Haliaeetus albicilla*), și unul din cele mai importante locuri din Bulgaria pentru cuibărirea mai multor specii stârc (*Nycticorax nycticorax*, *Ardeola ralloides* și lopătar (*Platalea leucorodia*). Au fost identificate peste 100 de specii de animale, din care 42 de nevertebrate terestre și 16 acvatice, 5 specii de pești, una de amfibieni și una de reptile, 30 de specii de păsări (din care 22 care cresc pui), 16 specii de mamifere (din care 8 de lilieci). A fost certificată prezența lipitorii medicinale (*Hirudo verbana*), o specie rar întâlnită în cadrul Europei, midia de râu cu cochilie groasă (*Unio crassus*), peștele viperă (*Leuciscus aspius*) și marele păianjen (*Dolomedes plantarius*), inclus pe Lista Roșie a Bulgariei, la categoria *extinct*. Un plan de management pentru rezervația Ibisha a fost elaborat în anul 2015.

Cuvinte-cheie: faună, rezervația Ibisha, insula Tsibar, situl Ramsar Ibisha

Introduction

Tsibar (Ibisha) Island is situated on Bulgarian part of Danube River, at 680 m of the Bulgarian and about 100 m from the Romanian coast, from 716 to 719 km along the river. Its area covers 1.3 km², the average height is about 3.5 m above the water surface and its maximum width is 550 m. The territory is covered mainly by riparian woodland which originated naturally as a result of the influence of the river stream. Tsibar Island is identified as the twenty-third largest among the Bulgarian Danube Islands. On its territory since

1984, part of the island is placed under strict protection as a managed reserve "Ibisha" (34.6 ha) and a protected area "Tsibar Island" located in the municipality Valchedram.

The island Tsibar is located on about 600-700 m in a straight line (Romania is only about a hundred meters away). Since it is built mainly of silt, the coast of the island is covered with fine sand, only in some places mud. The climate is continental. The average annual rainfall is 571.8 mm with February minimum and May or June maximum. The average monthly maximum temperature (August) is 36.8°C and the minimum temperature (January) is 14.7°C below zero.

The island consists of river sediments. In the western part there is a large sand bank without vegetation. There are river shallows around the island. The water regime is entirely dependent on the regime of the Danube. At high levels on the Danube (especially in spring) the lower parts of the island are flooded by river water. The temporarily flooded areas are occupied by forest vegetation, changing their position in time and space. The territory contains a specific habitat type – flooded riverine forest, which is rare in Europe and thus contributes to the conservation of biological diversity in the biogeographic region. It is assessed with an average value of biodiversity relative to the rest of Bulgaria. The most valuable element of the island vegetation is the flooded forests /associations dominated by Black Alder (*Alnus glutinosa*), Crack Willow (*Salix fragilis*), White Poplar (*Populus alba*) and Black Poplar (*Populus nigra*). There are also hygrophyte grass communities. The forests have a dense and practically impenetrable layer of lianas and Blackberry (*Rubus sp.*).

Because of its European importance to the protection of rare and threatened habitats, plants and animals, including birds, the island falls within the borders of proposed Natura 2000 sites under both the Birds and the Habitats Directives.

The boundary of the Ramsar site Ibisha Island covers the boundaries of the Natura 2000 sites under the Birds Directive: BG0002007 "Ostrov Ibisha", BG0002008 "Ostrov do Gorni Tsibar", BG0002009 "Zlatiyata" and BG0002104 "Tsibarsko blato", and the territory of Natura 2000 site under Habitats Directive BG0000199 "Tsibar". Cross-border wetland "Island Ibisha - Bistrets" with Romania exists since 2013.

The area around Ibisha Island and the two smaller islands downstream used to be one of the key sites for commercial sturgeon fishery in the Danube River section between Bulgaria and Romania. Despite of the tendency for steady decline the sturgeon populations were intensively exploited until the year 2000. After that a dramatic decline in the populations was reported and fishing was limited due to the lack of fish resources.

The closeness of the Tsibar Island to the Romanian coast is a cause for settling on terrestrial mammal fauna which can easily pass, especially in summer low water. Record low water periods were noted in 1919 and 2004. Of importance is also the occasional freezing of the Danube River, the last major event having been registered in the winter of 1984-1985.

The island is virtually uninhabited for most of the year, and human activity is very limited. There is seasonal work such as logging and hunting in the fall (October-December).

A characteristic feature of the Danube islands are their internal channels, called Zattons (Zattoni). In the spring fresh waters flood the islands and partially fill the channels. By the end of summer some of them dry, while others retain water until the next flooding. The existence of Zattons is a subject for specific biodiversity. Zattons are an important place for invertebrates, fish and amphibians, which serve as feeding base for birds and mammals.

Materials and methods

The field research in Ibisha reserve and the buffer zone were carried out in June - July 2014.

For identifying the species richness of **terrestrial invertebrates**, standard collecting methods and techniques were used: transect method with entomological sweep net, screening by using a Gilyarov's litter reducer (3/6 mm), pitfall trapping (13 traps (9/12 cm) with preservative formaldehyde- propylene glycol solution). The traps were situated in two groups - among scrub vegetation and near Zattons.

The identification of the taxa was according to field guides and relevant scientific papers. The collection of **aquatic invertebrates** was performed in high waters, where the depth of Zattons was about 1 m (21.06.2014) and after Zatton's drying (12.07.2014). For the collection of the invertebrate animals a manual frame and a light triangular dragger (EN ISO 10870:2012), were used - about 300 linear m along the cost of Zattons and a narrow area along the Danube river cost.

The estimation of local species richness of the **vertebrate species** was investigated by registration based on the transect method and direct visual observations and reporting of the existence of a species at a trace (Oshmarin & Pikunov, 1990) and of vital activity (footprints, excrement and others).

The **ornithological** observations were accomplished using a transect method along the south edge of the mixed nesting colony of Great Cormorant. The count of Spoonbills and Egrets was taken, with birds flying in and out from the colony and their nests. The count of Cormorant nests was also registered -mainly on the hybrid Poplar, and Spoonbills and Egrets nests on Elms.

The numbers of songbirds nesting around have been identified mainly acoustically.

Bats were recorded 30 - 40 min after sunset by using a D240X bat detector (Pettersson Elektronik AB, Uppsala) with a sampling rate of 307 kHz and a frequency range from 10–120 kHz. The calls were recorded for 30 to 120 minutes in each habitat, then converted to the *.wav format and analyzed by the Bat Sound software. Ultrasound recordings were identified according to Russo & Jones (2002).

Results and discussions

On Tsibar Island there have been identified more than 100 animal species: 42 terrestrial and 11 aquatic invertebrates, 5 fish species, 1 amphibian and 1 reptile species, 30 birds (including 22 breeding), 16 mammalian species (including 8 species of bats).

Invertebrates

The terrestrial invertebrate fauna on Tsibar Island was not a subject to particular research so far. Todorov et al. (2016) are the only authors mentioning Medicinal leech (*Hirudo verbana*) location near the Reserve.

During the field studies representatives of 42 species distributed in 29 families of terrestrial invertebrates were identified. Most of the established terrestrial invertebrate species are relatively widespread in Bulgaria and in Europe, dominated mainly by hygrophiles and water-related species. Among the investigated species no relicts, Bulgarian and Balkan endemics were discovered. The only exception is the German Hairy Snail (*Pseudotrachia rubiginosa*) and may be referred to the European endemics. As alien species has been established Multicolored Asian lady beetle (*Harmonia axyridis*). Since 2008 this species is known in Bulgaria and already widespread (Tomov et al. 2009, 2010a, b, Nedved et al. 2010). Due to its predatory and competitive abilities the species may have strong negative effects on biodiversity (Tomov et al. 2010b, Nedved et al. 2010).

Another snail species, *Helix pomatia* is relatively widespread.

Among Araneae the Great raft spider (*Dolomedes plantarius*) (in the Pisauridae family) was established in the Reserve area. The finding is of great importance; moreover this species was considered as extinct (EX) so far (Golemanski et al., 2011, Deltsev, 2011 and Deltsev et al., 2005) due to the degradation and loss of habitat (Deltsev, 2011). The Ibisha Reserve is the third finding point of *Dolomedes plantarius*, so this species confirmed its presence in the Bulgarian fauna. In Romania the Great raft spider is also known from the Danube delta (Babina Island) (Weiss et al., 1998) and this is the reason that it is possible to discover its presence on other Bulgarian and Romanian Danube islands. This spider inhabits lowland fen and grazing marsh areas and is dependent on the presence of standing or slow moving neutral to alkaline water. Within these areas it can be found on the margins of pools or ditches. Emergent vegetation is highly important for use as perches for hunting and basking and to support nursery webs. Because of that the Zattons and their surroundings are of great importance for the Great raft spider for feeding and surviving. Great

raft spiders are predatory and hunt from perches at the water's edge. They primarily feed on aquatic invertebrates such as pond skaters, dragonfly larvae, small fish and smaller aquatic spiders. They will also feed on drowning terrestrial invertebrates and have been known to catch small vertebrates such as sticklebacks and tadpoles (Deltsev, 2011). Although the species is widely distributed in Europe, under-recording and confusion over identification make assessment of its status difficult. Populations are known to have declined substantially throughout its range particularly in the Western and Central areas but remaining populations are believed to be well established in Scandinavia and the Baltic States. These reductions in population are primarily due to the degradation and loss of habitat. The great raft spider is listed as a vulnerable species on the IUCN Red List (https://en.wikipedia.org/wiki/Great_raft_spider).

The survival of the Great raft spider is unlikely without active conservation measures against the losses and degradation of its key habitats. Its populations are not numerous, and the species is sensitive to water pollution (Deltsev et al., 2005). This is the reason *Dolomedes plantarius* to be protected on regional level in the category "Critically Endangered".

The southern migrant hawk (Aeshna affinis) is also very common. This species prefers standing water bodies that dry up over the summer that are often overgrown with low rushes, bulrushes or reeds.

Three species from order Lepidoptera were also found: - the Passenger (*Dysgonia algira*) - a species of moth of the family Noctuidae, the Holly Blue (*Celastrina argiolus*) a butterfly that belongs to the Lycaenids and *Pieris rapae*, also known as the Cabbagewhite or Brassica butterfly.

The **aquatic invertebrates** are presented with species that are typical of the Bulgarian Danube marshes. From Order Hirudinida was established the Mediterranean medical leech (*Hirudo verbana* Carena 1820), survivor in shallower layers of fine bottom substrate after drying of the Zattton. This globally threatened invertebrate was also mentioned for the Belene Islands complex (Solakov, 2010).

In Central and Eastern Europe this species until recently was wrongly synonymised with *H. medicinalis* L. 1758 (Todorov et al., 2016) and like this it exists in the cited documents. At present it is on the procedure of document rectification.

From the mussels was found the Thick-shelled river mussel (*Unio crassus* Philipson, 1788), determined only by empty valves. This species is included in the International Union for Conservation of Nature (IUCN) threatened species in category in danger "EN". This mussel nowadays is almost extinct

from the Danube (Evtimova et al. 2014; Graf et al., 2015).

From the aquatic gastropod mollusks were identified Planorbidae spp.; Viviparus acerosus (Bourguignat 1862), Lymnaea stagnalis (Linnaeus 1758) and Stagnicola palustris (O.F. Müller, 1774). From the freshwater crustaceans an Aquatic sowbug (Asellus aquaticus (Linnaeus 1758) was found. Among the water insect species on Tsibar island and the reserve were found the Dragonflies Aeshna sp., Sympetrum sp. (order Odonata); Water beetles (Hydroporus marginatus Duftschmid 1805 (Coleoptera); Water boatmen (Corixidae spp.), Micronecta sp., Gerris sp., Plea minutissima (Leach, 1817) (Hemiptera). From the Order Chaoborus (Chaoborus) crystallinus (De Geer 1776) and Chironomus sp. were established.

Fish

The river stream around the island is important for the protection of the Danube sturgeon species, whose stocks significantly decreased in recent decades (Vassilev & Pehlivanov, 2003). On the other hand, the Danube River is a corridor for nonindigenous (invasive) fish species such as: Pseudorasbora parva, Neogobius spp., Gambusia holbrooki, Syngnathus abaster, Lepomis gibbosus, Percottus glenni etc. (Jurajda et al. 2006; Polačik et al, 2008a; Polačik et al, 2008b; Trichkova et al, 2014; Pavlova et al, 2014). Various anthropogenic negative impacts such as pollution, fishing, hydropower, change and loss of habitats are the cause of changes in the ichthyofauna of the Danube during the last decades. The presence of wetlands - swamps and marshes - is important for the reproduction of some important local species such as Northern Pike (Esox lucius), Wild Common Carp (Cyprinus carpio), Tench (Tinca tinca), Common Rudd (Scardinius erythrophthalmus), Weatherfish (Misgurnus fossilis) etc. (Pehlivanov et al 2011). Our studies of the swamp on the island of Tsibar (June 2014) showed the presence of thousands of individuals of juvenile fishes (2-5 cm length). Solakov (2010) also mentioned that Belene Islands complex has a significant role as a nursery for about 20 fish species.

The marsh is a favorable habitat for the growing the larvae of fish and is essential for maintaining biodiversity in the Danube River. On the other hand, larvae are good trophic resource for fish-eating birds from the colonies in the island. After our results, the most abundant were Carp and Topmouth gudgeon (Pseudorasbora parva, (Temminck et Schlegel, 1846)). Only single specimens were found from: Asp (Leuciscus aspius L., 1758); Bream (Abramis brama L., 1758) and Loach (Cobitis sp.). With conservation importance is only the Asp. (Golemanski, 2011).

Amphibians and Reptiles

The Bulgarian Danube islands are poorly explored in a herpetological respect. Data published for amphibians and reptiles originate from six scientific publications and refer for four islands. Described are seven species of amphibians (one species of the order Caudata and six species of the order Anura) and two species of reptiles (1 species of order Testudines and 1 species of the suborder Serpentes; both are closely related to the water). The species distribution of on different islands is as follows:

Belene Island (Persina) – Common Spadefoot Toad (Pelobates fuscus (Laurenti, 1768)), Eastern Spadefoot Toad (Pelobates syriacus Boettger, 1889), European Tree Frog (Hyla arborea (Linnaeus, 1758)), Marsh Frog (Pelophylax ridibundus Pallas, 1771), European Pond Turtle (Emys orbicularis Linnaeus, 1758) and Grass Snake (Natrix natrix Linnaeus, 1758) (see Stoyneva & Michev 2007a, Undjian 2000);

Oreh Island (Esperanto) – Hyla arborea, Edible Frog (Pelophylax kl. esculentus Linnaeus, 1758) and Pelophylax ridibundus (see Beškov 1972, Stoyneva & Michev 2007b);

Vardim Island (Beskut) – Danube Crested Newt (Triturus dobrogicus Kiritzescu, 1903) (see Buresch & Zonkow 1941);

Kosui Island – Common Toad (Bufo bufo Linnaeus, 1758) (see Buresch & Zonkow 1941).

For the other Bulgarian Islands (more than 40 in total) no literature data for amphibians and reptiles are available. During our studies on the Tsibar island were identified two species: Marsh Frog (Pelophylax ridibundus) - dozens of individuals and the Aesculapian snake (Zamenis longissimus (Laurenti, 1768)) - one individual. In Bulgaria P. ridibundus occurs ubiquitously (an exception being the high mountains), while Z. longissimus inhabits mainly mountainous and foothill areas but in the Danube valley it is spread sporadically (Stojanov et al. 2011). The first species is closely related to water and it has been reported on the other islands. The second type is entirely terrestrial and locating it on Tsibar island indicates that the Danube islands have the potential as a habitat for reptiles, which are not directly dependent on the water.

So far, it cannot be said to what extent the species richness of herpetofauna on the Danube islands depends on their size, their distance from the coast and the nature of their plant cover. It has to be mentioned that the biggest number of species (total 6) were found on Belene Island - the largest in area Bulgarian island (several times larger than others). As a result of our research into the herpetofauna species composition to the island has to be added the Aesculapian snake (Zamenis

longissimus). A final clarification of species diversity of amphibians and reptiles of the Bulgarian Danube islands, as well as the factors that define it is necessary to be provided in targeted and large-scale studies.

Birds

The ornithofauna of the Bulgarian Danube coast as part of the exclusive biodiversity of the Lower Danube has been of great interest for the researchers since the middle of 19th century (Lorenz-Liburnau, 1893; Reiser, 1894; Kalbermatten, 1891; Paspaleva-Antonova, 1961; Spitzenberger, 1966, Paspaleva & Mitshev, 1968, Iankov, 2007, Schurulinkov et al., 2008) and also of special interest to Boev, 1992, Antonov, 1995, 1997a, b; Shurulinkov et al., 2007. Data concerning the bird species on Tsibar island is possible to be found in SD forms of the Natura 2000 sites under the Birds Directive: BG0002007 "Ostrov Ibisha", BG0002008 "Ostrov do Gorni Tsibar", BG0002009 "Zlatiyata" and BG0002104 "Tsibarsko blato", and the Romanian "Bistret" ROSPA0010 and „Coridorul Jiului“ ROSCI0045.

As a result of the present research over 30 bird species were established. It is possible to accept that only at the reproductive period the ornithofauna in the Ibisha reserve is composed of 22 nesting species (field data and UTM square GP05). Another 106 species are passing, wintering and accidental (UTM data square GP05 and BGSPA0002007), altogether 128 bird species. Data concerning the structure and the conservation status of 22 breeding bird species are presented in Table 1.

Table 1: Structure and conservation status of the ornithofauna in Ibisha reserve (only breeding species are included)

Category	Number of species
Residents	8
Breeding summer visitors	14
Bird Directive, Annex I	7
Red Data Book of IUCN, category NT	1
Red Data Book of Bulgaria, category CR	2
Red Data Book of Bulgaria, category EN	0
Biodiversity Law, Annex III	18

By the zoogeographical analysis of breeding bird species (Voous, 1960) in the reserve Ibisha it was established that they belong to 7 zoogeographical regions. The most numerous are the species with palearctic zoogeographical origin, following by species with European origin (species of the Old world) - 4, and Europe-Turkestan and Turkestan-Mediterranean origin - 2 and 1 species with Ethiopian origin.

A special interest from the conservation point of view represents the long-term species observation and the quantitative composition of the nesting colony of the great cormorants', egrets and herons in the reserve. The colony is recognizable from 1972 (Michev & Petrov, 1984) and in the last years a lot of changes have occurred in a number of species and their quantitative composition (Table 2).

Table 2: Long-term survey of species and quantitative (in breeding pairs) composition of cormorant and heron breeding colony in the managed reserve "Ibisha"

Species	Boev (1992)	Antonov (1997a,b)	Shurulinkov et al. (2007)	June2014	Breeds since:
Great Cormorant (<i>Phalacrocorax carbo</i>)	100	180-200	450-500	150-200	1985
Pygmy Cormorant (<i>Phalacrocorax pygmeus</i>)	20-40	12	55-60	non breeding	1988
Black-crowned Night Heron (<i>Nycticorax nycticorax</i>)	80-100	250	120-140	100-125	<1984
Squacco Heron (<i>Ardeola ralloides</i>)	10	50	3	10-15	1986
Great Egret (<i>Egretta alba</i>)				3-5	2014 г.
Little Egret (<i>Egretta garzetta</i>)	60-80	300	110-130	85-90	<1984
Grey Heron (<i>Ardea cinerea</i>)	20-25		60 -70	50-80	1972
Purple Heron (<i>Ardea purpurea</i>)		2-3		non breeding	
Spoonbill (<i>Platalea leucorodia</i>)	Tens	10	6	20-25	1990?

For first time the Reserve's territory was established as a nesting site of the Great Egret (*Ardea alba*). Breeding pairs of Pygmy Cormorant (*Phalacrocorax pygmeus*) and Purple Heron (*Ardea purpurea*) were not registered.

There were also increases in the number of the gray heron, but a decrease of the *Spoonbill* (*Platalea leucorodia*). For the other species stable breeding populations were established.

The northern part of the island was used for the cultivation of hybrid Poplar and forestry. This activity combined with human presence causes a disturbance of cormorants' and egrets' nesting colonies, especially in the breeding season. Instances of illegal logging have also been established (Antonov, 1997) combined with a direct nests' destruction of egrets and cormorants of the colony (Boev, 1992).

According to the local fishermen, north of the nesting colony a White-tailed Eagle (*Haliaeetus albicilla*) nest was located. In the Tsibar Island region and fishponds in Bistret in 2010 adult Sea Eagles have been observed twice (on the nameless island near village Gorni Tsibar and of the northern shore of the lake Bistret in Romania). During research of the feeding areas of breeding water birds a Eurasian Stone-curlew (*Burhinus oedipnemus*) with strongly pronounced nesting behavior was observed.

The obtained results in the present study confirmed once again the scheme of the spatial distribution of the water birds nesting colonies in the Lower Danube. The islands are used for nesting and the wetlands along the left bank of the river - for a basic feeding base. They confirmed also the great importance of the island as a Ramsar site, EU Natura 2000 site and Menaged reserve.

Mammals

The mammalian fauna on the Bulgarian Danube islands is not well studied. More information is possible to be found for the Romanian islands - Cama-Dinu (km 511 – 505), Mocanului and Albina islands (km 412 – 401), Slobozia islets (km 498 – 495) (Murario, 2005), and for the Danube Delta where 5 orders: Insectivora (7 species), Lagomorpha (1 species), Rodentia (21 species), Carnivora (15 species) and Artiodactyla (2 species) were described (Murario, 1996).

According to present concepts of the area and habitat preferences of mammals (Peshev et al. 2004; Popov & Sedevchev 2003; Popov et al. 2007) it can be assumed that on the island territory is found about 16 mammalian species (including 8 species of bats).

Because of the low ability of mammals to overcome barriers to their resettlement, the mammal fauna on the island is represented fairly

poorly and in low numbers. The entire site is inhabited by small rodents of the *Microtus* and *Apodemus* genera, with relatively low numbers;

The Yellow-necked field mouse (*Apodemus flavicollis*) is a common species on Tsibar Island. Murariu (2005) established an important population of this species and of *Apodemus uralensis* on Albina Island. The most prolific Microtidae species - the Common vole (*Microtus arvalis*), is surprisingly present in the forest skirts of the studied island.

Regarding the bat fauna, it is one of the least studied areas in Bulgaria. Until 2003, reports of bats in this area accounted for only 1.9% of all reports for the presence of bats in Bulgaria (Benda et al. 2003). Only eight species of bats, known from the territory of Tsibar Island were recorded (24.2% of total 33 species, inhabiting Bulgaria, belonging to the Family Vespertilionidae) despite that the Island offers good feeding conditions for all bat species.

Bats from the gender *Myotis* are present in high numbers, but due to the proximity of the shape and parameters of their echolocation sounds, the species determination is difficult. From the undefined *Myotis* species it is unlikely that the Greater Mouse-eared Bat (*Myotis myotis/blythii*), but it was recorded on the Island with the explanation that *M. myotis* can migrate up to 200 km away from its winter roosts.

The Serotine Bat (*Eptesicus serotinus*) is typical mainly for rocky terrains, but often is common in other habitats and is regarded as ubiquitous.

The Common Noctule (*Nyctalus noctula*) is one of the most frequent bats (Decu et al. 2003) and, along with the Lesser Noctule (*Nyctalus leisleri*) is a forest species, preferring deciduous forests and often settled in tree hollows.

The most widespread bats on the island are these of the genus *Pipistrellus*, which are mainly synantropic and/or dendrophilic, inhabiting deciduous forests.

One species - the Schreiber's Bent-winged Bat (*Miniopterus schreibersii*) is a typical cave species, but it was not reported from the banks of the Danube. The identification of the species using the bat detector (with frequencies of 53 – 55 kHz), can be accidental on Tsibar Island (maybe for feeding). It comes there from the Bulgarian bank of the Danube where karst formations are presented. It was also registered by (Murario, 2005) from the Cama-Dinu Island. This species probably overflows to the area due to the extremely favorable food and habitat.

When studying the bat fauna of the islands Batin and Vardim in June 2012, Serotine Bat (*Eptesicus serotinus*), Common Noctule (*Nyctalus noctula* /*N. leisleri*), *Myotis* Bats (*Myotis* sp.), Common Pipistrelle (*Pipistrellus pipistrellus*), Nathusius' Pipistrelle (*P. nathusii*) were established. The high similarity in the

bat fauna of the three Danube islands (Tsibar, Batin and Vardim) is due both to the similar vegetation and closeness to populated areas. This is the reason for the establishment of synanthropic species of the genus *Pipistrellus*. The absence of *M. schreibersii* on Vardim and Batin Islands is due to the lack of shelters there.

Of particular importance as a migration corridor is the valley of the Danube River, where the adjacent humid vegetation and riparian forests provide not only multiple daily shelters for migratory populations, but also create conditions necessary to feed them. In fact, dominant species composition is not differentiated from that found over open arable lands, but the continuous presence and activity of bats is considerably higher.

Individual representatives of the European Roe Deer (*Capreolus capreolus*) visit Tsibar Island mainly from the left (Romanian) bank of the Danube (Murariu, 2005).

Numerous is the population of the Wild Boar (*Sus scrofa*). It is frequently occurring in most of the Danube islands (Murariu, 2005).

The Golden Jackal (*Canis aureus*) has also been noted - those occurrences were possible especially during the heavy winters, when it could cross the frozen Danube, mainly from Bulgaria to Romania.

Tsibar Island offers enough good conditions for the Red Fox (*Vulpes vulpes*), the European Badger (*Meles meles*) and at least for the rather large population of the Least Weasel (*Mustela nivalis*).

The European Otter (*Lutra lutra*) was established in all sections of the Danube River with preserved natural and dense vegetation (even forests on the Danubian Islands which offer the optimum conditions this species needs) including the swamps, fish breeding-ponds and lakes near the Danube River, but currently sufficient data is not available (Georgiev & Koshev, 2006). Murariu (2005) observed otter tracks on the shores of the Cama, Slobozia islets and Albina Island.

One of the factors affecting adversely the ecological character of the island is the entry of different invasive species causing changes of the native fauna communities.

Invasive species have many ecological effects and may threaten biological diversity (Hulme, 2007; Vilà et al., 2010). Alien species may alter the habitat, and predate on, or compete with native fauna or be important vectors of diseases and parasites. The Raccoon Dog (*Nyctereutes procyonoides*) is one of the most successful alien carnivores in Europe. It has spread rapidly into many European countries after being introduced by Russians during the first half of the 20th century. The Raccoon Dog has been suspected of causing damage to native fauna through predation, but firm

evidence of this is scarce (Lavrov, 1971; Nasimović & Isakov, 1985; Kauhala, 2004). Raccoon Dogs may also compete with native medium-sized carnivores, such as the Eurasian Badger (*Meles meles*) and the Red Fox (*Vulpes vulpes*) (Jędrzejewska & Jędrzejewski, 1998; Kowalczyk et al., 2008). The preferred habitats of Raccoon Dogs are wet open habitats: damp meadows and forests with sparse canopy but abundant undergrowth, marshlands, river valleys and gardens.

The successful expansion of Raccoon Dogs in Europe was also possible due to their tendency to wander, the secretiveness of the species and low persecution at the beginning of invasion. Raccoon dogs are nocturnal animals, utilizing mainly wet habitats covered with dense vegetation and showing inactivity in winter.

In north-eastern Poland, the diet of Raccoon Dogs overlaps 41% with Red Foxes and 35% with Badgers in spring and summer. In winter, the diet overlap between Raccoon Dogs and Red Foxes increases to 62%, when both species utilize more carrion. Other species that Raccoon Dogs may compete with are semi-aquatic species like the Otter (*Lutra lutra*)—33%; Jędrzejewska & Jędrzejewski, 1998).

Amphibians (e.g., *Rana* spp., *Bufo* spp., *Bombina* spp. and *Triturus cristatus*) commonly occur in the diet of Raccoon Dogs in the spring and summer (Ivanova, 1962; Lavrov, 1971; Jędrzejewska & Jędrzejewski, 1998; Sutor et al., 2010). Both adult frogs and tadpoles are easy prey for Raccoon Dogs and this may cause a decline in frog populations, especially on islands and in other fragmented or isolated areas (Sutor et al., 2010).

Management plan

In 2014 a Management Plan of the managed reserve "Ibisha" was established based on its relevance to the ecology and conservation of the typical Danube island communities - riparian woodland, forests and marshes, as well as refuges for rare and endangered plant and animal species. The plan aims to increase public awareness about the opportunities, the importance and the value of the reserve. For the complete faunistic, botanical and ecological studies different scientific projects will be developed. For an effective management, a database is also foreseen to be created. It is necessary to improve the control of the entry into the reserve, but also to enhance the knowledge concerning the nature of Ibisha Island.

Conclusion

The riparian woodland, forests, swamps and Zattons on Tsibar Island are an integral part of the Danube migration corridor, which is of prime

importance for the distribution of many invertebrates, fish and fish-eating birds during their nesting and migration.

At present the distribution, abundance and species composition of the most of animal's groups including the bats is unclear. This requires specialized studies. Little is still known on the impact of raccoon dogs on the native fauna.

As a whole the fauna of Tsibar Island is characterized by high vulnerability. Most of the species associated with the Danube wetlands are easily vulnerable, with insufficient numbers and with strong dependence on the water level of the Danube, especially at the low levels when many of the species do not reproduce at all.

The preservation of the natural diversity in one of the largest and most remarkable riparian woodland areas like Tsibar Island is of great conservation importance.

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Classification, Typology and Distribution of Solification Rocks in Romania

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Abstract

The present paper seeks to contribute to the better knowledge of the parental rocks of different soil types that are found in Romania, as well as their share in the country's territory. During its geological-geographical evolution, on Romania's territory various geological (petrographic) formations have been formed, from crystalline rocks to loams, sands, fluvial and organic deposits. Because the types of rocks are numerous and their territorial distribution changes in narrower areas, the paper aims to group them according to their associating mode, genesis, as well as to their contribution to soil formation.

The paper introduces a new map of solification rocks in Romania, scale 1:1.000.000, which aims not only to their theoretical classification, but also to determine the surfaces occupied by each category, and their distribution on the country's major relief units. In addition to the new map, achieved after the processing and updating of different cartographical materials using GIS techniques, information regarding the soil types formed on each category of parental rocks is provided.

Keywords: *solification rocks, pedology, petrography, soils, Romania*

Rezumat. Clasificarea, tipologia și distribuția rocilor de solificare din România

Prezenta lucrare caută să aducă o contribuție la cunoașterea tipurilor de roci parentale ale solurilor ce se găsesc pe teritoriul României, precum și a ponderii acestora.

În decursul evoluției sale geologico-geografice, pe teritoriul României s-au format un număr foarte variat de formațiuni geologice (petrografice), de la roci cristaline la luturi, nisipuri, depozite fluviale sau organice. Pentru că tipurile de roci sunt numeroase, iar distribuția lor teritorială se schimbă pe spații restrânse, lucrarea își propune gruparea lor după modul de asociere, după geneză, precum și după contribuția la formarea solurilor.

Lucrarea introduce o nouă hartă a rocilor de solificare din România, scara 1:1.000.000, care are ca scop nu numai clasificarea lor teoretică, dar de asemenea și determinarea suprafețelor ocupate de către fiecare categorie, și distribuția acestora pe unitățile de relief majore ale țării. În plus față de noua hartă, Pe lângă noua hartă, rezultată în urma prelucrării și actualizării diverselor materiale cartografice folosind tehnici SIG, sunt oferite informații cu privire la tipurile de soluri formate pe fiecare categorie de roci parentale.

Cuvinte-cheie: *roci solificare, pedologie, petrografie, soluri, România*

Introduction

Romania's relief is varied and diverse, encountering all relief steps, from the continental platform of the Black Sea to the massif ridges of the Carpathian Mountains (Fig. 1). This diversified scenery formed over different geological eras, which left their marks through the various petrographic formations encountered.

The petrographic diversity, combined with the relief, climate and vegetation layers, led to the formation of a large number of soil types, with different properties and characteristics. This wealth of nature, which is the source of food for animals and humans, brought an increased attention of researchers for pedological analyses, these aiming to protect and sustainably exploit soil resources.

The scientific community in Romania has undertaken numerous pedological studies in the whole country, particularly conducted by the

Research Institute for Soil Science and Agrochemistry Bucharest, through its branches in all counties (Offices for Pedologic and Agrochemistry Studies), but also by researchers from the main university centers. Over the years there were published many scientific papers related to the formation, classification and distribution of Romania's soils, having a regional character (Munteanu, 1996; Grigoraș, 1999; Grigoraș and Simulescu, 2012) or representing a synthesis of the pedological research (Florea et al., 1968; Ianoș, 1999; Munteanu, 1994; Blaga et al., 2005).

Thus, this paper aims to update the classification of solification rocks taking into account the Romanian system of soil taxonomy (Florea and Munteanu, 2003; 2012), by creating a new digital map for Romania, but also the spatial and quantitative distribution of these solification rocks categories.

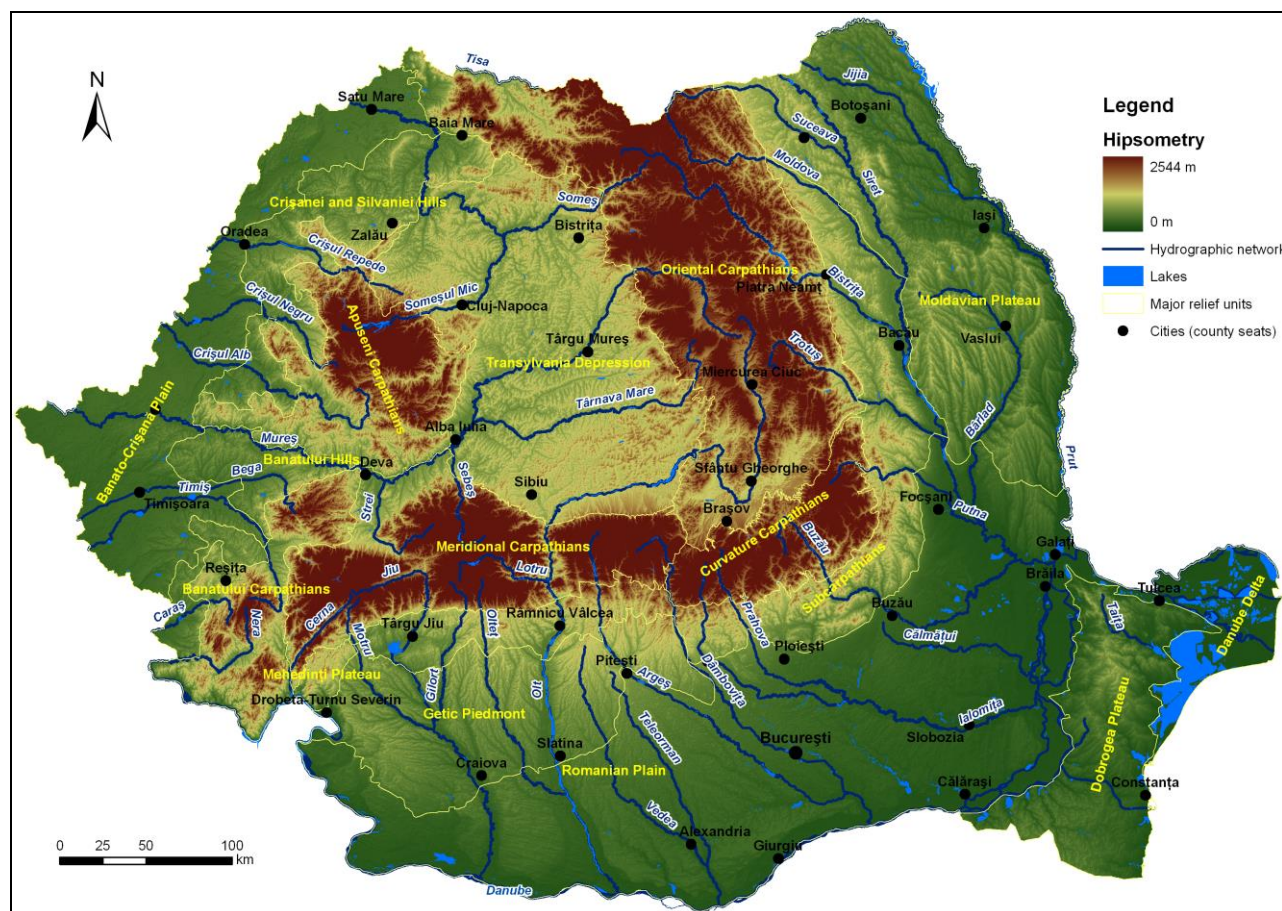


Fig. 1: Major relief units in Romania (*processed after Posea and Badea, 1984*)

Data and methods

The present study was conducted for the whole country and totals an area of 238.391 km².

In order to achieve the new classification, there were digitized and vectorized, using GIS techniques, a series of cartographic documents such as: the Romanian map of Solification deposits, scale 1:1.000.000 (Munteanu et al., 1992), the Relief units map of Romania (Posea and Badea, 1984), and for better details the Soils map of Romania, scale 1:200.000 (Institute of Research for Pedology and Agrochemistry, Bucharest) and Geological map of Romania, scale 1:200.000 (Geological Institute, Bucharest).

The new obtained data, processed and updated using GIS techniques, were then categorized taking into account the classification criteria used in literature (Munteanu, 1996; Grigoraș et al., 2004; Florea and Munteanu, 2012). Thus, there were

established a nine solification rocks categories. We also determined the area covered by each category of rocks, their distribution within Romania as well as the correlation with the soil types that have developed on these parental materials (using Grigoraș et al., 2006; 2008, soil types classification).

Results and discussions

After digital processing, a new map of solification rocks in Romania was obtained (Fig. 2), these types of rocks being grouped into 3 large classes (crystalline rocks, volcanic rocks, sedimentary rocks) and several categories (crystalline rocks, volcanic rocks, calcareous rocks, gypsum, salt, detrital rocks, sandy deposits, loamy deposits, clayey deposits, alluvial and alluvial-proluvial deposits, organic deposits).

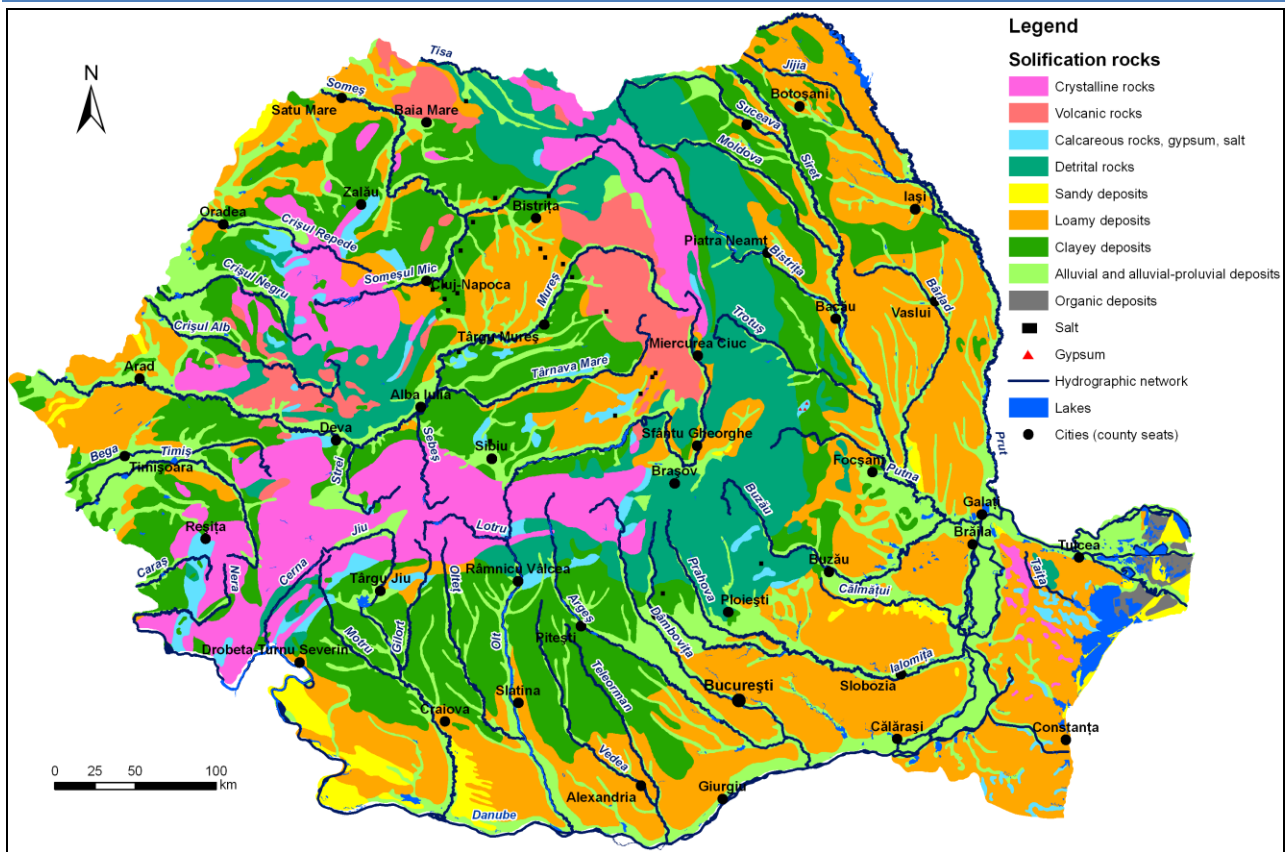


Fig. 2: Map of Solification rocks in Romania, scale 1:1.000.000 (processed after: Parental materials and rocks map – ICPA Bucharest archive, Soils map of Romania sc. 1:200.000, Geological map of Romania sc. 1:200.000)

1. Crystalline rocks

In this group there were included acid igneous rocks such as granite, granodiorite etc., non-acid igneous rocks (intermediate and basic) as syenite, diorite or gabbro, then crystalline metamorphic rocks such as crystalline limestone and crystalline schists.

We find crystalline rocks spread over an area of about 26,041 km² or 10.92% of the country's territory, their territorial distribution being related to the mountainous region.

Granitoids (3332.75 km² – 1.40%) appear on small areas within the Banat Mountains, respectively in the northern part of the Dognecea Mountains, then on isolated areas in Almăj, Semenic and Locvei Mountains, and in the southern part of Poiana Ruscă Mountains. Within the Apuseni Mountains, granite appears in the western part of Zarand Mountains, respectively in Highiş Massif and Bihor Mountain. In Eastern Carpathians, granitic rocks are mentioned in Giurgeu Mountains. Several areas with granitoids are found in the Southern Carpathians, in Retezat and Godeanu Mountains. Also, granitic rocks are found in the Măcin Mountains in Northern Dobrogea.

Intermediate and basic igneous rocks are found in Almăj Mountains from the Banat

Carpathians, where in a narrow area (101.90 km² – 0.04%) there appear gabbro, peridotite and dunite.

Metamorphic rocks are the most spread crystalline rocks, and among them, crystalline schists predominate (21,924.28 km² or 9.19% from the country's surface). They are present in large areas in the Southern Carpathians, respectively in Făgăraş-Iezer, Parâng-Cindrel and Retezat-Godeanu Mountains. Within the Western Carpathians, they are encountered in Semenic-Almăj, Poiana Ruscă, Zarand, Bihor, Gilău, Plopiş and Meseş Mountains. In the Eastern Carpathians, crystalline schists are scattered in Maramureş, Rodnei, Bistricioarei and Giurgeu Mountains. On smaller areas, they appear in Perşani Mountains and in Central and Northern Dobrogea Plateau.

A narrower category (682.07 km² or 0.29%) is the one of **crystalline limestones**, which are found in association with crystalline schists. These rocks are found in several areas in the Făgăraş, Poiana Ruscă, and in the south of Bihor Mountains, as well as within the Eastern Carpathians in Giurgeu Mountains.

On crystalline rocks, relatively varied soils were formed, which are conditioned by the local climate, as well as by the slope. On the highest ridges of the mountains, we find Umbrisols, Spodosols and

Lithosols, while at lower altitudes Dystricambosols, and locally, Luvisols or even Lithic Chernozems in Dobrogea.

2. Volcanic rocks

The category of volcanic rocks covers an area of about 8660.21 km² or 3.63% of Romania's territory, their presence being primarily related to Neogene volcanism. There were set up three groups: i) andesite, tuffs, pyroclastics, ii) volcanogenic sedimentary formations and iii) basalts, melaphyre, diabase, lahar deposits. On these rocks there were formed soils with Andic properties, like Andosols, Andic Eutricambosols or Andic Dystricambosols.

Andesites, tuffs and pyroclastics occupy more than half of the total area of volcanic rocks in Romania (4662.11 km² – 1.95%). The most important areas are present in the Eastern Oriental Carpathians, being wide-spread in the northern part of the volcanic mountains, like the Oaș, Igriș, Gutâi, Lăpuș, Țibleș Mountains. Then, these rocks are present in the Bârgău, Călimani, Gurghiu and Harghita Mountains. Smaller areas are distributed in the Apuseni Mountains, like in Metaliferi Mountains, Codru and Miseș Massifs. In the hilly region, they may be found in the Western Hills, in Bulzei, Cigherului and Teuzului and in Codru Moma Hills, respectively, as well as within the Someș Plateau, Cluj and Dej Hills.

Volcanogenic sedimentary formations (2812.26 km² – 1.18%) are spread on important areas within the Gurghiu-Harghita and Călimani Mountains. Smaller areas are found in Gheorghieni Depression, Ciuc, Bodoc, Baraolt and in Poiana Ruscă Mountains.

Basalts, melaphyres, diabases and lahar deposits appear on smaller areas (1185.84 km² – 0.5%), important areas being distributed within the Metaliferi, Trascău, Maramureș and Perșani Mountains.

3. Sedimentary rocks

This group of rocks is dominant in surface, stretching on 202,655.82 km² or 85.01% of the country's territory. In this group, there were framed seven important subgroups.

3.1 Calcareous rocks, gypsum, salt

This group includes soluble rocks, such as limestones, dolomites, marls, gypsums and rock salt. Gypsums and rock salt emerging only locally, occupying very limited areas, so they don't appear as territorial units on the map.

Calcareous rocks (limestones, dolomites and marls) are predominant, being distributed over an area estimated at approx. 4956.08 km² which accounts for 2.12% of the country's area. Out on the field, we meet various situations which we are going to analyze below.

Limestones occupy 3290.54 km² or 1.42%, being present mainly in the mountainous region.

Areas with limestone are found in the Banat Mountains, respectively in Anina, Locva and Mehedinți Mountains, within the Apuseni Mountains in Codru Moma, Pădurea Craiului, Bihor Mountains and Padeș Plateau. Within the Southern Carpathians, these rocks are found in the southwestern part of Hațeg Depression and in Piatra Craiului Mountains. In the Eastern Carpathians, there are some limestone surfaces in Rodna Massif, Bucegi, Perșani Mountains and Codlea Hillock. Large areas are found in Dobrogea, in Babadag Plateau and the southern part of Tulcea Hills, then in Cernavodă, Carasu, Cobadin and Mangalia Plateaus.

Within Pădurea Craiului and Giurgeu Mountains there are found areas with limestone and dolomite, while within Almăj Mountains, the southern part of Mehedinți Plateau, central part of Metaliferi and Trascău Mountains are areas with limestone associated with calcareous sandstones.

On these types of rocks we often encounter Rendzinas, Rendzinic Lithosols, Rendzinic Chernozems, Rezicalcaric Phaeozems, Rezicalcaric Preluvosols and others.

Marls, which stretch on a surface of 1665.54 km² or 0.70%, are spread mostly in the hilly region, being often associated with clays. They are found in the Oltenian Subcarpathians – Săcelul Hill, then in Argeș Hills – Runcul Hill, Buzău Subcarpathians – Istrița Hill, Vrancea Subcarpathians – Oușor Hill. Within the central part of the country, marls with clays can be found in the central and southeastern part of Hârtibaci Plateau, in the northern part of Târnăveni Plateau and in the southern part of Dumbrăveni Plateau.

In some cases, marls are associated with clays and limestones, being present in some areas in Mehedinți Plateau, Siriu Mountains, Clujului Hills and Almaș-Agrij Depression.

Marls can be found sometimes together with sandstones and conglomerates. This associations of rocks is present in the northern part of Bulzei Hills and in Lovișteea Depression.

On marls, there are encountered a wide range of soils; they are usually soils having eutric properties, such as Chernozems and Pararendzinic Phaeozems or Eutricambosols and Vertisols.

Gypsums appear only on a small area, which can't be reproduced at the map's scale. We mention their presence in the western part of Oușorul Hill, at the contact with Vrancea Mountains.

Salt is found only punctual, its appearance being linked to diapirs. In the external part of the Subcarpathians, it is mentioned in Salcia Hill from the western part of Buzău Subcarpathians and in Ocnița Hill, in the west of Ialomița Subcarpathians. Within the Transylvanian Plateau, the appearance of salt cores is known in Târnăveni Plateau near Ocna Mureș, in Hârtibaciului Plateau near Ocna Sibiu in

the western part and near Rupea, in the eastern part of the plateau. Then, three emergences are found in Homoroadelor Subcarpathians. Farther north, is the well-known salt core from Sovata, and in the Subcarpathian Hills of Bistrița and Mureș appear salt emergences west and north of Reghin and west of Șieu. In the northern part, salt frequently emerges near the Someș Valley, in Fizeș Plain, north and south of Gherla and west and north of Beclean.

Within the areas where these rocks appear, we often encounter Salsodisols or different types of soils with salsodic properties.

3.2. Compact detrital rocks

Several groups of rocks were included in this category: sandstones, conglomerates and flysch. They spread over an area of 26,797.05 km² or 11.24% of the country's territory. The geographical distribution is related mainly to the mountainous region, but they are also found within the Subcarpathians, the hilly or plateau areas.

Sandstones

This category of compact detrital rocks are found mainly within the Carpathian region, but also in the Subcarpathians and the plateau area. They occupy a surface estimated at 9078.17 km² or 3.81%. Among them, there are a couple of associations that will be detailed below.

Calcareous sandstones with marl-limestone (437.05 km² – 0.18%) appear only in a few areas in the south-western part of Poiana Ruscă Mountains, in Cerna and Bârgău Mountains.

Sandstones with sands, clays and marls have a wide distribution (4428.58 km² – 1.86%), being found within Țibleș Mountains, Maramureșului Hills, Bârgău Mountains and northern part of Bistrița Hills, in Hășmaș Mountains, in Husului Massif from Mureșului Mountains and in the Curvature Subcarpathians.

Sandstones with conglomerates, clayey schists and limestones sum up an area of 3993.93 km² or 1.68%. They are found in Maramureș Mountains and Hills, in Bucovina Hills, in Goșmanu and Bistrița and Codru Moma Mountains, as well as in Buzău Subcarpathians.

Sandstones without calcareous cement (218.60 km² – 0.09%) are found in an area situated in Niculițel Plateau in Northern Dobrogea.

Conglomerates

Conglomerates often appear in association with sandstones, sandstones and limestones or with marls, sandstones, clays and sands, occupying an area of 7921.89 km² or 3.32%.

Conglomerates proper appear in only one area (318.83 km² – 0.13%) in the western part of Bucegi Mountains.

Conglomerates with sandstones are found on a surface of 6408.63 km² or 2.69%. They are

found within Pădurea Craiului, the eastern half of Mureș Mountains, Aninei Mountains, in south-western part of Cerna and Țarcu Mountains, the western part of Mehedinți Plateau, Loviște Depression and Ghițu Massif. Within the Eastern Carpathians, conglomerates and sandstones appear in Postăvaru, Teleajen and Întorsura Buzăului Mountains, as well as in Baraolt, Giurgeu, Ciuc, Ceahlău, Rarău-Giumalău Mountains and in Mestecanis Hills.

Conglomerates with sandstones and limestones are found in two areas (176.80 km² – 0.07%) situated in Cozia and Pădurea Craiului Mountains.

Conglomerates with marl, sandstone, clays and sands are present in Ghițu Massif and Perșani Mountains, the three areas summing up a surface of 1017.63 km² or 0.43%.

Flysch

Flysch is a petrographic formation specific to the Eastern Carpathians, covering an area of 9796.99 km² (4.11%). There were distinguished two categories: calcareous flysch and sandstone flysch.

Calcareous flysch occupy in total an area of 2545.34 km² or 1.07%. They are distributed in Mestecăniș Hill, Stânișoara, Troțuș and Întorsura Buzăului Mountains, as well as in Bodoc and Baraolt Mountains.

Sandstone flysch is spread over a surface that reaches 7251.65 km² or 3.04%. Areas with such rocks are present within Neamț, Ciuc, Tarcău, Troțuș, Vrancea, Buzău and Baiul Mountains. They also appear within Ialomița Subcarpathians and Argeș Hills.

On detrital rocks the soil cover is mainly constituted by Eutricambosols in the case it presents calcareous elements or Dystricambosols in case of absence of calcium carbonate. Apart from these soils there are found Luvisols, Spodosols, Lithosols and others.

3.3. Mobile detrital rocks

This category of rocks, disposed on a surface of 5527.93 km² (2.32%) is made up by two distinct groups, gravels and sands.

Gravels

On the field, there were distinguished two types of gravels: calcareous gravels and siliceous gravels.

Calcareous gravels (706.17 km² – 0.30%) are present within Ciuc Mountains, Teleajen Subcarpathians, Piatra Mare and Postăvaru Massif, Codlea Hillock and the eastern part of Făgăraș Depression.

Siliceous gravels (382.91 km² – 0.16%) are present in Ceahlău and Giurgeu-Ciuc Mountains, as well as in Tazlău and Vrancea Subcarpathians.

Sands

In this category we have distinguished a couple of subcategories: carbonatic continental sands,

reshuffled by wind; noncarbonatic continental sands, reshuffled by wind; coastal sands, frequently reshuffled by wind, with varied conchiferous and carbonatic fluvial sands.

The sandy rocks are found spread over an area of nearly 4500 km² (4438.85 km²) or 1.86 % of the country's territory. On them, mainly Psamosols have been formed but also other soils which have a sandy texture, like Chernozems, Phaeozems, Eutricambosols etc.

Carbonatic continental sands, reshuffled by wind occupy an area of 668.26 km² – 0.28%. The largest areas with such deposits are found in the Romanian Plain, respectively in the northern part of Ialomița Plain (Bărăganul Ialomiței) towards the contact with the floodplain of the Călmățui river. On narrower areas, they are found in Aranca and Arad Plains (part of Banat Plain), and there are a few areas in Northern Dobrogea Plateau, northwest of Măcin Mountains and in the eastern extremity of Murighiol-Dunavăț Hills.

Noncarbonatic continental sands, reshuffled by wind, are the most wide-spread category on Romania's territory (2032.07 km² – 0.85%). Large areas are found in Blahnița, Desnățui and Romanați Plains (part of Oltenia Plain). An important area is found in Carei Plain, at the Hungarian border, known as Valea lui Mihai Plain. Other small areas are mentioned in Brașov Depression, the part known as Râul Negru Depression and in the south of Moldavia, within the western and eastern part of Tecuci plain.

Costal sands, frequently reshuffled by wind, with various conchiferous (836.02 km² – 0.35%) are costal sandy deposits found on the actual shore of the Black Sea, but also in the Danube's Delta on the many levees from its fluvio-maritime part, which were once the shoreline. Thus, in the northern part of the Delta between Chilia and Sulina anabranches we mention Letea, Cardon and Ivancea Levees, while further south, between Sulina and Sfântul Gheorghe anabranches, there are sandy deposits on Sărăturile, Caraorman and Roșu Levees; south of Sfântul Gheorghe anabranch such deposits are found on Bulhaz, Țigănuș, Crasnicol, Dranov, Perișor, Lupilor, Histria and Chituc Levees.

Carbonatic fluvial sands (902.50 km² – 0.38%) are materials brought and deposited by the Danube in the floodplain. The most significant areas can be found in southern Oltenia Plain, west of Drincea's shedding into Danube, then east of Calafat and in Bistreț and Potelu floodplains.

3.4. Loamy rocks (deposits)

Loam deposits are the most wide-spread formations on Romania's territory. They cover an area estimated at 67,241.38 km² or 28.21%.

The deposits of this group consist of two major categories: i) Loess and loess-like deposits and ii) Silt deposits.

Loess and loess-like deposits

Several categories fall within this group: a) loess proper and loess-like deposits which weren't differentiated; b) loess-like deposits, frequently paleo altered; c) loess-like deposits and fluvial deposits; d) loess-like deposits, clays, marly clays and locally sands and e) thin loess-like deposits on sands.

Loess and loess-like deposits occupy the largest areas in Romania, being distributed on a surface of 57,496 km² or 24.12%.

Undifferentiated loess and loess-like deposits are the main category, occupying an area of 37,168.80 km², respectively 15.59% of Romania's territory. They are found within the great plains, such as the Romanian Plain, from Oltenia and Teleorman up to Bărăgan, as well as within the Western Plain with Banat and part of Crișuri and Someș Plains. Then important surfaces are found in Moldavia, Transylvania Plains, Râmnicul Piedmontan Plain and in Dobrogea Plateau. On narrower areas, these deposits are present on some terraces of the rivers, such as Mureș, Olt, Olteț, Argeș, Someș, Siret, Suceava, Moldova, Bistrița, Bârlad etc. or on Chilia Levee from Danube's Delta.

Loess-like deposits, frequently paleo altered are materials with a loamy-clayey predominant texture and a reduced content of calcium carbonate. They cover an area of nearly 11,480.50 km² or 4.82%. They are distributed in northern Oltenia Plain and in southern Bălăcița Piedmont, in northern Teleorman Plain, Vlășia and Ialomița Plains, and in the Western Plain in Bârzava, Vinga, the High Crișuri and Ier Plain from the southern part of Someș Plain.

Loess-like deposits and fluvial deposits appear in the lower parts of some plains or in some depressions (2377.33 km² – 1%). The most important areas are found in Banat Plain (Beregsău, Aranca and Arad Plains), then in the Lower Someș and Turda Plains, as well as Brașov and Ciuc Depressions.

Loess-like deposits with clays, marly clays and local sands (6290.77 km² – 2.64%) are an association of rocks in which predominant are loess-like deposits, but due to erosion, there appear layers of clays, marly clays and locally sands on the valleys slopes. The most important areas are in Central Moldavian Plateau, (Racova and Vaslui Plateaus) and in Tutova and Fălciu Hillocks. A small area is found in the western part of the country, in Barcău Depression.

Thin loess-like deposits on sands (178.60 km² – 0.07%) are present only in one area located in the north-eastern part of Mostiștea' Plain

(Bărağanul Mostiștei), towards Ialomița's valley, named Ciulniței Field.

Loamy deposits

Loamy deposits are materials with loamy to loamy-clayey texture, other than loess and loess-like deposits. They occupy an area estimated at 9745.38 km², which represents 4.08%. In this category there were included several grouped loam and other types of deposits.

Deluvio-proluvial loams (360.87 km² – 0.15%) were formed at the contact of one higher territory with a lower one. Although their presence is mentioned in many places, an important area is located on the left bank of Timiș river, on the terraces and glaciis at the contact of Lugoj Plain with Buziaș and Pogăniș Hills.

Loams and clays (1192.91 km² – 0.50%) are present in Oradea Depression at the foothills of Barcău Hills, Crasna Hills and Arduș Plain from the High Someș Plain. Then there are some areas in Huedin Plateau and in Hăjdate Depression from Feleac Hills.

Loams and sands (723.82 km² – 0.30%) are found in some areas from Feleac Hills, Făget Depression from Bega Hills and in the depressions from northern Oltenia, in Cărbunestii, Bumbești-Novaci and Polovragi-Hurez Depressions, respectively.

Loams with sands and gravels (2129.65 km² – 0.89%) form an association of rocks which are spread across several locations in the country. It is present at the foothills of Oaș Mountains towards Someș Plain and Oaș Depression, Maramureș Piedmont and Almaș-Agrij Depression. In Târnave Plateau, there are some areas in Secaș, Mediaș, Târnăveni Plateaus situated at the contact between the plateau and the floodplain of Târnava Mare or Mureș. These deposits are present in Râul Negru Depression from the north-eastern part of Brașov Depression, in Vrancea Depression and in Răcoasa Depression from Șușița Hills. Finally, a small area is found in Dăbuleni Plain from southern Romanați Plain.

Loams with sands, volcanic tuffs and marls form the largest spread association of materials at surface (5338.13 km² – 2.24%). Important areas are present in Sărmaș Plain, south-eastern part of Fizeș Plain and in western part of Bistrița Hills, then in northern Homorade Subcarpathians and Hârtibaci Plateau. These deposits are also found in Oaș, and Cracău-Bistrița and Soveja Depressions.

On loamy deposits, soils from the Cernisols, Luvisols, Cambisols classes are mainly formed, but Regosols, Psamosols, Erodosols and rarely Salsodisols are also found.

3.5. Clayey rocks (deposits)

Clayey deposits are the second largest category at the country's level. They occupy a surface

estimated at 50,340.60 km² or 21.12%. Their genesis is very varied, so there were established more categories: residual clays from calcareous rocks, limestone; residual clays (red) other than those from limestones; swelling clays (smectitic); sandy clays; clays on sands and/or gravels; clays and marly clays (frequently swelling), marls with or without sandy intercalations, loams, sometimes sandstones and limestones; clays, loams, sandstones, sands with or without gravels; clays, volcanic tuffs, sands, loams; undifferentiated clays.

Appearing in very different environmental conditions, these deposits have formed a varied number of soils, from Cambisols, Cernisols, Luvisols, to Vertisols, Salsodisols and others.

Residual clays from calcareous rocks come from the alteration of calcareous rocks. They occupy narrow areas (452.55 km² – 0.19%) situated in the calcareous mountainous massifs, such as the ones from the Western Carpathians, i.e. Anina, Locva, Bihor, Codru Moma, Pădurea Craiului and Metaliferi Mountains. These deposits are found also in the Southern Carpathians, in Mehedinți and Parâng Mountains, respectively.

Residual clays (red) others than those from limestones (936.10 km² – 0.39%) have various origins, being distributed in several locations in western Highiş Massif from Zarand Mountains, Buduslău and Tășnad Plains, Almaș-Agrij and Vlaha-Hăjdate Depressions.

Swelling clays (smectitic) (6211.26 km² – 2.60%) are made up from clayey minerals in which the smectitic ones are predominant. The areas with these deposits are distributed in all the regions. The most important areas are found in Banato-Crișana Plain, Moldavia in Siret and Upper Jijia Plains and in Elan Hillocks, the southern part of the country in Motru Piedmont, Jiu and Amaradia Hills, Bălăcița and Olteț Piedmonts, Găvanu-Burdea and Ploiești Plains. Some areas with smectitic clays are also present in Cigher Hills and Secaș Plateau.

Clays and marly clays (frequently swelling), marls with or without sandy intercalations, loams, sometimes sandstones and limestones are spread mainly in the hilly region, occupying an area of 16,564.30 km² or 6.95%. The areas are distributed in Oravița and Dognecea Hills, Codru Moma, Silvania Hills, Lăpuș Subcarpathians, Secaș, Târnăveni and Hârtibaci Plateaus and in Târnava Mica Hills. In Moldavia, these deposits are found in Dragomirna, Fălticeni and Solca Plateaus, then in Bașeu, Sitna Hillocks, Siret Hill and Neamț, Tazlău and Vrancea Subcarpathians. In the south, important areas are found in Mehedinți Plateau, Tismana-Ștefănești Depression, Oltețul Subcarpathians and Argeș Hills.

Clays on sands and/or gravels appear only locally (574.05 km² – 0.24%), being spread in

Făgăraș Depression on the glacis at the foothills of the Făgăraș Mountains.

Sandy clays occupy small areas ($685.99 \text{ km}^2 - 0.29\%$), being distributed in only few locations from Bumbesti-Novaci Depression, Oradea Hills, Vrancea Subcarpathians, Hăpăi Hills (Siretul Hills) and Bașeu Plain.

Clays with loams, sandstones, sands with or without gravels are quite wide-spread ($11,937.70 \text{ km}^2 - 5\%$), appearing in both the hilly region and in the area of some mountainous ridges. In the western part of the country, they are found in Liubcova, Bozovici, Caransebeș and Mehadica Depressions, as well as in Pogăniș, Lugoj, Lăpugiu, Lipova, Codru Moma, Beiuș and Sylvania Hills. Within the Transylvanian Depression, such deposits are present in Someșan Plateau (Cluj, Bobâlna, Ciceu Hills, Boiul Plateau and Prisnel Hill) and Sibiu Depression. Important areas are found in Oltenian Subcarpathians, Olteț and Cotmeana Piedmont, Argeș Hills, Ialomița Subcarpathians (Ocnița Hill) and Jitia Depression from Vrancea Subcarpathians. In the mountainous region they are present in Hațeg-Orăștie, Brașov Depressions and in Stânișoara, Bistrița, Tarcău mountainous massifs and in the southern part of Goșmanu and Berzunt Mountains.

Clays with volcanic tuffs, sands and loams ($1894.75 \text{ km}^2 - 0.79\%$) are spread in the north-western part of Transylvania, respectively in Bistrița Hills, Fizeș Plain and Aiud Hills.

Undifferentiated clays is a wide-spread category ($11,083.90 \text{ km}^2 - 4.65\%$), areas with such clays being present in several locations in the country. Thus, they are found in Oravița, Cigher Hills, Cermei, High Crișuri Plains, Hidișel Hill and Barcău Hills. In the north-western part of the country the clays are spread in the west of Oaș Mountains and in Cluj Hills. In Moldavia, they appear in the south of Boul-Ibănești Hill, Bașeu Hillocks, Dragomirna Plateau and Poiana Ciungilor Hill, and in the south part, on Blăjani Ridge from Vrancea Subcarpathians. In Muntenia, they are found in Câlniștea and Pitești Plains, Cândești and Cotmeana Piedmonts, and in the south of Vulcana Hill from Ialomița Subcarpathians; westwards of Olt river, they are spread in Olteț and Bălăcița Piedmonts, Jiu hill and in the north of Bran hill.

3.6. Alluvial deposits

This group includes the materials transported by rivers and temporary flowing waters and deposited in the floodplains and other lowland areas. In their case there were distinguished two situations: alluvial deposits proper and alluvial-proluvial deposits.

Alluvial deposits proper is the widest-spread category, occupying a surface of $43,055.30 \text{ km}^2$ or 18.07% from the country's territory. The distribution area is represented by all the meadows of the rivers, including the Danube Delta.

Alluvial-proluvial deposits are less spread ($3553.12 \text{ km}^2 - 1.49\%$), being mainly found in intra or extra-Carpathian depressions, such as: Petroșani, Hațeg, Brașov, Sibiu, Beiuș, Oradea-Borod, Alba Iulia, Baia Mare, Oaș, Dornei, Maramureș, Gheorghieni and Baraolt. Also areas with alluvial-proluvial deposits are found in Târgoviște Plain and in Sărata Plain from Ialomița Plain.

On these deposits Aluviosols, Gleysols, Salsodisols, Chernozems, Eutricambosols and others are formed.

3.7. Organic deposits

Organic deposits are accumulations of vegetal organic materials based on the vegetation that grows in swamps and lakes. They cover a surface of 1084.36 km^2 or 0.45% . They are almost entirely distributed in the Danube Delta. Narrow areas, but which couldn't be reproduced at the map's scale, are found also in the rest of the country, such as Crasna Plain, Brașov, Giurgeu, Ciuc, Bilbor, Borsec Depressions etc.

On organic deposits Histisols are formed.

Conclusions

The presence of the main relief steps (plain, hill, mountain), influenced the occurrence of the main pedogenetic factors, the diversity of the physico-geographical conditions determined a varied soil cover.

This variety of soils is due to the variety of parental rocks, the present paper manages to classify the solification rocks, to evidence their distribution, as well as to determine the surfaces occupied by each rock type.

Out of the 3 main groups of solification rocks identified, the largest share is owned by sedimentary rocks, which occupy about $202,655 \text{ km}^2$ (85.01%), followed by crystalline rocks ($26,041 \text{ km}^2 - 10.92\%$) and volcanic rocks ($8660 \text{ km}^2 - 3.63\%$).

The largest areas are occupied by loamy rocks and deposits ($67,241 \text{ km}^2 - 28.21\%$), clayey rocks and deposits ($50,340 \text{ km}^2 - 21.12\%$) and alluvial and alluvial-proluvial deposits ($46,608 \text{ km}^2 - 19.55\%$).

The variety of parental rocks determined the formation of no less than 29 soil types, grouped into 12 classes, which are described and included in the Romanian system of soil taxonomy (SRTS).

Using GIS techniques, through processing and updating different cartographic materials, a new digital map of the solification rocks in Romania (scale 1:1.000.000), was achieved, which is intended to be a source of information for geographers and other specialists who are interested in soil science and environmental protection.

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The Standardization of the Services in Farm-stay Tourism – The *EuroGites* Method as a Possible Solution

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Abstract

This study assessed conceptual terms of farm-stay tourism through connection with the criteria of quality of services. Based on best practices and experiences from the European countries, the European Federation of Rural Tourism (*EuroGites*) has established common quality assessment standards for accommodation units in rural areas. Criteria of established standards are grouped into five clusters: equipment, surroundings, services at the accommodation and its surroundings, non-material aspects and security. This paper aims at a comparative analysis between the minimal conditions for international and domestic markets, through the assessment of the farm-stay tourism quality segments. In this respect, the research has been conducted in the selected villages in Vojvodina Province (Northern Serbia) by using *EuroGites* methodological instrument. The main hypothesis of the paper was based on the estimation that quality of farm-stay tourism in Vojvodina Province is measurable by the extent to which they comply with the *EuroGites* criteria in the domestic and international level. The results showed that the three sub-hypotheses are confirmed, and two of them are disproved. The research findings represent a useful tool for obtaining information about many aspects of quality in farm-stay tourism and, with slight modifications, it can be used in various areas of quality research.

Keywords: *EuroGites*, criteria clusters, quality segments, farm-based accommodation, Vojvodina Province (Northern Serbia)

Rezumat. Standardizarea serviciilor în cadrul turismului la fermă – metoda *EuroGites* ca o posibilă soluție

Acest studiu evaluează conceptele legate de turismul la fermă în concordanță cu criteriile calității serviciilor. Plecând de la exemple de bune practice și experiențele statelor europene, Federația Europeană a Turismului Rural (*EuroGites*) a stabilit o metodologie comună și standarde de evaluare a calității unităților de cazare din zonele rurale. Criteriile pentru standardele stabilite sunt grupate în cinci clustere: dotare, spațiul înconjurător, servicii oferite în cadrul unităților de cazare și împrejurimile acestora, aspecte non-materiale și securitate. Lucrarea își propune să realizeze o analiză comparativă între condițiile minimale de pe piața internațională și internă, în urma evaluării calității turismului la fermă. În acest sens, au fost analizate anumite sate din provincia Voievodina din nordul SERBIEI, folosind metodologia propusă de *EuroGites*. Am plecat de la ipoteza că se poate estima calitatea turismului la fermă în provincia Voievodina în funcție de măsura în care sunt îndeplinite criteriile *EuroGites* la nivel național și internațional. Rezultatele arată că toate cele trei sub-ipoteze sunt confirmate, și două infirmate. Rezultatele acestei cercetări pot fi un instrument util pentru a obține informații despre multe aspecte ale calității turismului la fermă și, în urma unor mici modificări, pot fi folosite ulterior și în cadrul altor analize calitative.

Cuvinte-cheie: *EuroGites*, clustere de criterii, segmente ale calității, cazare la fermă, provincia Voievodina (nordul Serbiei)

Introduction

The Republic of Serbia possesses exceptional resources for the development of numerous aspects of (continental) tourist activities, especially farm-stay tourism (agritourism). Serbia's wealthy, attractive and well-preserved natural resources, many traditional agricultural households, gastronomy and the growing interest of the international market in rural lifestyle and motives point towards great potential for the farm-stay tourism development. This should be an obvious alternative possibility for development in rather large parts spanning over this region. It is a way of utilizing comparative advantages of rural areas too. In Serbia, as well as in many other European countries, farm-stay tourism or agritourism is an

important factor of multifunctional rural development (Knickel and Renting, 2000; Ohe, 2007; Brankov et al., 2015; Petrović et al., 2015; 2016a; 2016b). Together with these, tourism currently has strong advantages on the international economic market, as it has already played a key role in the rural development of some areas that were economically and socially depressed (Sznajder et al., 2009; Todorović and Bjeljic, 2009; Bjeljic et al., 2014; Štastná et al., 2015). Nevertheless, the standardization of services in Serbia in this economic area is still undetermined and unclear. The problems in creation and implementation of the unique quality standards in rural aspects of tourism are obvious in the rest of Europe as well. In this regard, the theorists in this scientific area have been searching for solutions to establish the standardization in this segment of tourist economy. They have been

looking for the ways to assess the quality of accommodation units, which are a part of the offer of rural tourism aspects, such as farm-stay tourism. As Roberts & Hall (2001) stated, it is extremely complicated to compare the quality of products and services in rural settings, with services offered by a city hotel, villa or a seaside resort. If the concept of agritourist product involving only a set of tourist services and activities at agritourist units and self-service beds in rural areas is accepted, then there can be a specific analysis of the quality of such product, which was proven by many earlier researchers (Hall and Richards, 2000; Reichel et al., 2000; Sirgy and Cornwell, 2001; Nickerson et al., 2001; Sirgy, 2001; Hall et al., 2003; Adams, 2008; George et al., 2009; Sznajder et al., 2009).

In connection with previous studies and according to the examples of good practices and experiences from European countries, the European federation of rural tourism (*EuroGites*) has suggested unique *EuroGites Quality Assessment Standards for Rural Accommodation* for all the country members. In 2016, the Federation had 35 professional organizations from 27 European countries (including Serbia), which offered a choice of about 100,000 places for the accommodation in rural areas (<https://www.eurogites.org/>). The established quality standards of this Federation represent the result of the agreement achieved during the General Assembly of the Federation in 2005, and which was supported by all the members at that time (*EuroGites – Version 1.0b*, 2005).

Since then, the *EuroGites* standards have been explained and applied by many authors in their references (Buselić et al., 2008; Spanos & Doman, 2011; Stoian, 2011a; 2011b; Gherasim, 2012; Caprarescu et al., 2013). It has been stated that these standards are efficient tools for analyzing a great number of quality offer aspects. Together with this, they are, as such, very applicable in the most various rural areas, which has already been done in the examples of Romania, Croatia, Greece, etc. Since the established quality standards are efficiently applied in a great number of European countries, the aim of this study will be application of these standards in Serbia (the case study of selected villages in the Vojvodina Province in Northern Serbia¹). In the discussion, the actual answers will

be presented, i.e. the results of their testing according to the pilot research in the analyzed villages.

Methodology

The established standard clusters (criteria) are grouped into five blocks. The clusters are defined according to the results of the international tourists' attitude research towards the quality of rural aspects of tourism until 2005, in order to discover and define their needs. The research was then repeated during 2009 and 2010 among the examinees from 40 European countries. After the ordinal number and the description, clusters were divided into two columns, more precisely, each item of this document had a criterion concerning the *minimal conditions for domestic market* and the criterion which defines *minimal conditions for the international market*. The examinees answered the questions with "yes" (I fulfill the set conditions) or "no" (I do not fulfill the set conditions) for both criteria. The block segments were divided into two columns, namely, each item of this document has a criterion referring to the domestic or national market and a criterion referring to the international one (<https://www.eurogites.org/documents/>).

Block 1 (Equipment of agritourist accommodation units) comprises 19 criteria and deals with the amenities of agritourist accommodation units, where the main criteria are focused on the inner segments, such as technical-technological, sanitary-hygienic, organizational and spatial aspects of the units. The equipment in this case means the aspects from the building style of the house(s), decoration and preservation of the place, over the size, dimensions and contents of the rooms, to the presence and the equipment of a bathroom, heating and air-conditioning of all the rooms where guests stay.

Block 2 (Surroundings of agritourist accommodation units) involves nine criteria and concerns the closer and further surroundings of an agritourist accommodation unit. The focus is on the exterior impacts (natural and anthropogenic), level of preservation of the surrounding rural environment with the emphasis on cultural heritage and preserved natural potentials in the surrounding. The authors of standards also note that in this block, the important feature is the emphasis on social responsibility and the responsibility for the local surroundings and environment by the hosts, as well as the necessity to advise with interested local participants (other people in the home production of food, drinks and beverages, salespeople, craftsmen, tourist guides etc.) in farm-stay tourism.

Block 3 (Services in agritourist accommodation unit and its surroundings up

¹ The selection of the village settlements has been done according to the recommendations of a National Project "Wealth of Diversity", supported by the Provincial Government of Vojvodina Province. According to their established criteria, the project committee has evaluated and made a list of the 17 most representative villages in Vojvodina, in respect to agritourism development and affirmation. The selected villages are the following: Banoštor, Bački Monoštor, Bezdan, Belo Blato, Donji Tavankut, Golubinci, Gudurica, Kovilj, Krčedin, Ruski Krstur, Selenča, Skorenovac, Stapar, Stari Slankamen, Totovo Selo, Turija and Velebit.

to 15 km) comprises nine criteria, which contain aspects connected with maintenance of the rooms and spaces for providing services of alimentation of the guests, as well as recreational possibilities and the access to the agritourist accommodation unit itself. Within this Block, the emphasis is on the segment of guests' being informed about general information from the closer and further surroundings, as well as the list of information and instructions for the guests inside the accommodation unit.

Block 4 (Personal attention, privacy and ambience in an agritourist accommodation unit) includes seven criteria and concerns the communicative and psychological aspects on the

relation of a host towards guests. In this block of criteria, the emphasis is on the importance of communicative skills of the host, the expression of pleasant welcome, availability of the host during the guests' stay, as well as the knowledge of target foreign languages of the countries, where most of the tourists come from. If not, it is recommended to have a good knowledge of English, as the dominant world language.

Block 5 (Security in agritourist accommodation units) comprises nine criteria, which are based on the secure conditions the tourist place should fulfill. Among those criteria, the most outstanding ones are: technical, health-hygienic, legal, booking etc.

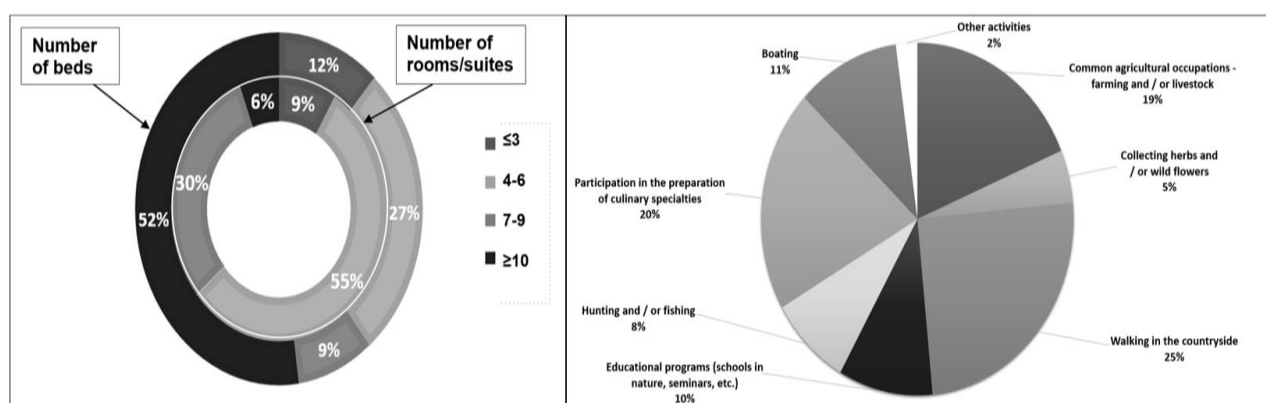


Fig. 1a/b: The structure of service providers' offer

In case of Serbia, the questionnaire was created according to the *EuroGites standards*, with the aim to assess the quality values of agritourist accommodation units. The questionnaire is meant for direct service providers in farm-stay tourism. The structure of their offer is presented in the Figure 1a/b. From the total of 100 sent poll questionnaires, 69 have been returned filled in. It can be easily concluded that, even though they are identical in many ways, the conditions for the international market are significantly more rigorous and demanding when the majority of the mentioned cluster criteria are concerned, which will be presented in more details in the following figure presentations.

According to presented criteria, the main hypothesis (**H1**) of the paper states that quality of farm-stay tourism in Vojvodina Province is measurable by comparing to degree to which conditions on the national and international level are fulfilled (Figure 2). This hypothesis is formed according to the suppositions of the obtained results using *EuroGites* methodology, where the conditions fulfillment will be tested in five assigned criteria, on the international and national level. In the results of the paper, the hypothesis will be proved or refuted

by using *EuroGites* methodological instruments. This hypothesis includes five sub-hypotheses:

H1a: *Equipment of agritourist accommodation units satisfies the criteria to a large extent according to national standards, but to a lesser extent according to international standards.*

H1b: *Surroundings of agritourist accommodation units satisfy the criteria to a large extent according to national, but to a lesser extent according to international standards.*

H1c: *Services in agritourist accommodation units satisfy the criteria to a large extent according to national, but to a lesser extent according to international standards.*

H1d: *Dedication to a guest, privacy and atmosphere in agritourist accommodation units satisfy the criteria to a large extent according to national standards, but to a lesser extent according to international standards.*

H1e: *Security in agritourist accommodation units satisfies the criteria to a large extent according to national standards, but to a lesser extent according to international standards.*

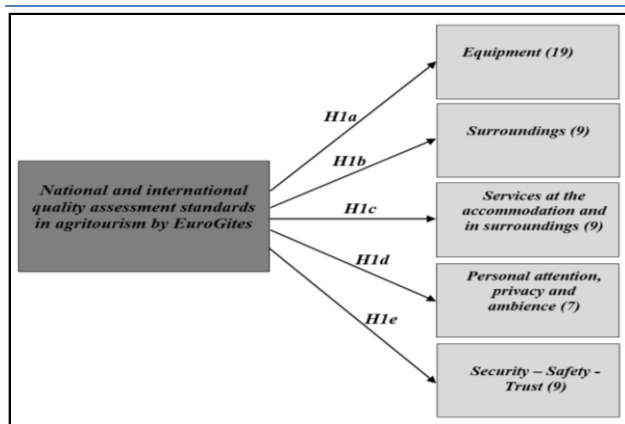


Fig. 2: The theoretical model of the research

Results and discussions

As it has been explained earlier, the segments of *EuroGites* quality standards refer to five blocks of criteria, i.e. conditions. The number of examinees whose accommodation units meet the criteria on the national and international level will be presented in this chapter. Each category within the five blocks will be valued according to the number of affirmative answers, which have been obtained according to the assigned criterion (domestic or international). The values will be qualitatively interpreted according to the numerical indicators

and will be titled as: *Very high value* ($N \geq 60$), *High value* ($N = 45-59$), *Middle value* ($N = 30-44$), *Low value* ($N = 15-29$) and *Very low value* ($N \leq 14$).

According to the results of the *Block 1* (Figure 3), it can be concluded that the largest number of examinees ($N = 67$), according to both criteria (domestic and international), fulfill the conditions in the category "lighting / windows in rooms" and "running water supply". These are also the basic conditions, which are bound to be fulfilled because the criteria on both levels are equal and obligatory. On the other hand, two examinees have given a negative answer, so it is believed that their facilities are still in the process of adaptation (exterior renovation or interior changes). The absolute majority of the examinees satisfy extremely high values ($N \geq 60$), because they fulfill the criteria for the domestic market in categories "equipment in bathrooms" ($N = 65$), "size of a single bedroom" ($N = 62$) and "overall cleanliness" ($N = 61$). Within these categories, there are clear criteria, which are regulated by national or local legal acts. It is interesting to mention that the category "size of beds" ($N = 49$), according to *EuroGites* standards for international market is absolutely equal to the regulations in the Serbian national legislation.

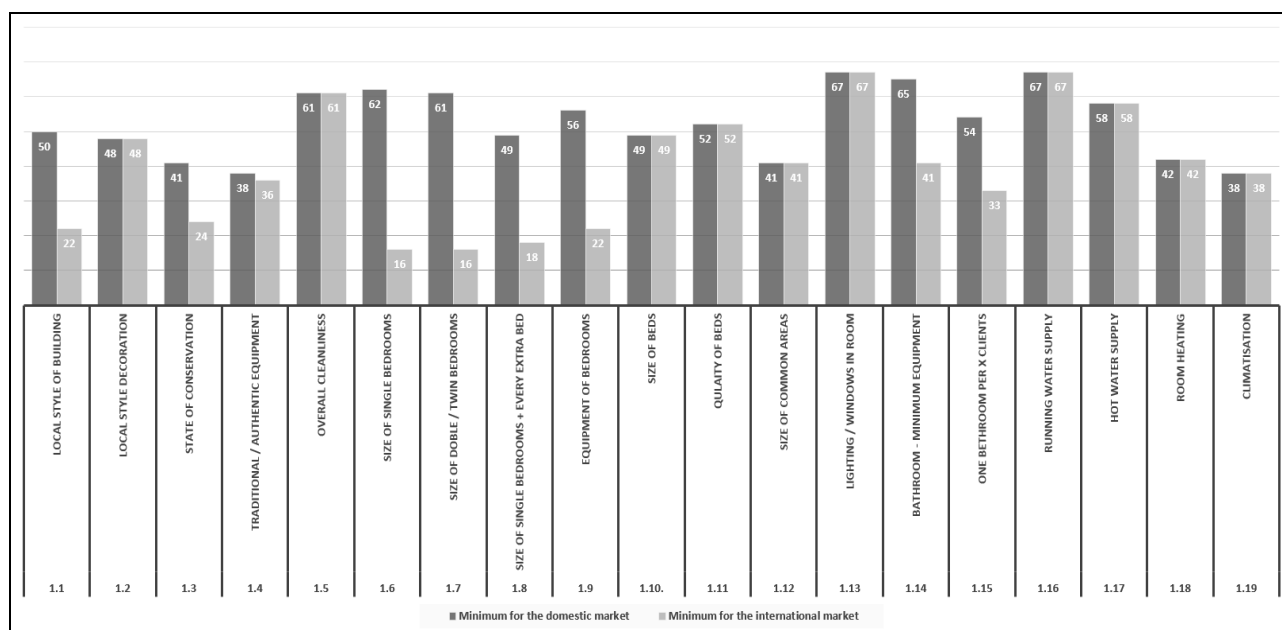


Fig. 3: Overview of the results of achieved standards according to criteria in *Block 1* ($N = 69$)

On the other hand, it should be noted that an extremely small share of positive answers according to the international regulated standards show low values ($N \leq 29$). Such values are noticeable in the categories: "local style of building" ($N = 22$), "state of conservation" ($N = 24$), "equipment of bedrooms"

($N = 22$), "size of single bedrooms" ($N = 16$), "size of a double / twin rooms" ($N = 16$), "size of single bedroom + for every extra bed" ($N = 18$). All the other indicators are in the range of middle or high values ($N = 30-59$) so they will not be further discussed. The obtained results prove the sub-

hypothesis *H1a* that the equipment of agritourist accommodation units satisfies the criteria according to domestic standards to a larger extent and to a lesser extent according to the international standards (10 out of 19 cases). When it comes to the observed settlements, farm-based accommodation units in Bački Monoštor, Belo Blato and Skorenovac have recorded the highest values for this indicator.

The presented results of *Block 2* (Figure 4) show that very high values ($N \geq 60$) according to both of the criteria (domestic and international) can be noticed in the categories "contribution to local

development / local production" ($N=67$), "social and cultural responsibility" ($N=66$), "rural surroundings of accommodation" ($N=66$) and potential "impacts or nuisance" ($N=64$), such as noise, visual nuisance, unpleasant smells etc. Such a value level can also be noticed in the category "resources 1: nature, landscape, scenery, etc.", but there is a mild difference between the conditions for the domestic market ($N=68$) and the conditions for the international market ($N=67$). The same and similar values according to both criteria are expectable since similar or identical conditions exist in *EuroGites* standards on both levels.

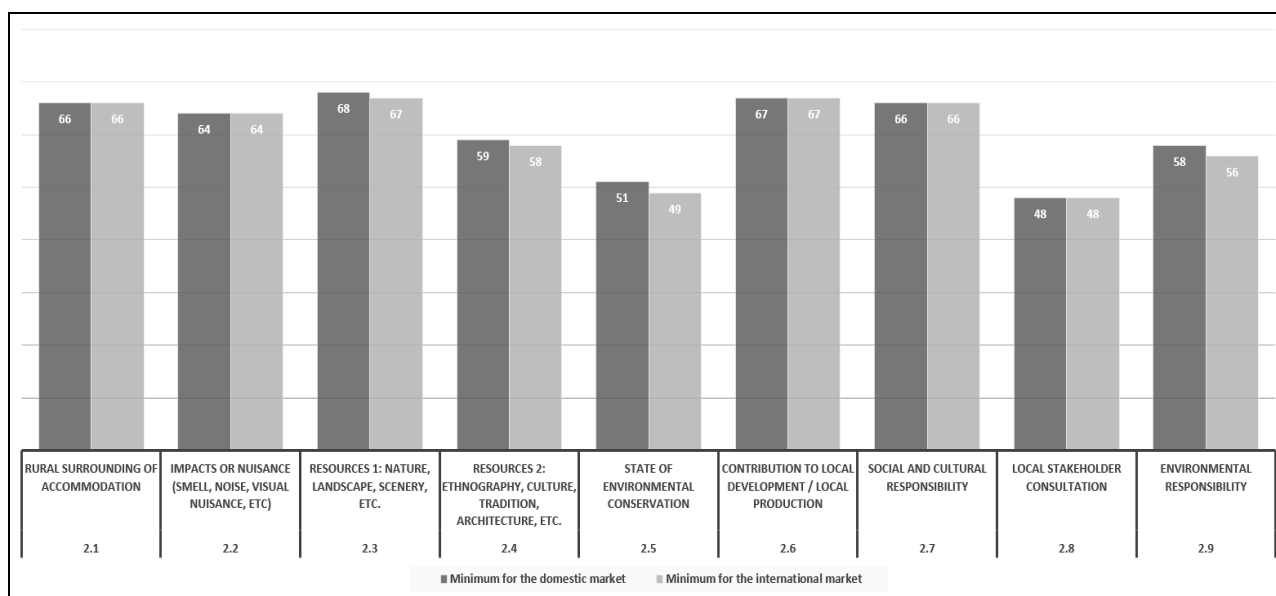


Fig. 4: Overview of the results of achieved standards according to criteria in *Block 2* ($N=69$)

On the other hand, the lowest values in this block are noticed in the categories "state of environmental conservation" ($N=49$), according to the international criteria and according to both criteria in the category "local stakeholder consultation" ($N=48$). Contrary to the previous figure, the lowest values obtained in this block are categorized as high values ($N=45-59$), according to general classification. Such results suggest that the specific feature in the first case ("state of environmental conservation"), where it is expected that the standards which are present in the majority of EU country members (e.g. high ecological awareness, organized management of rubbish, highly efficient public service, recycling centers etc.) are still not present in Vojvodina (Serbia). Also, the supposition is that in the categories "local stakeholder consultation" a bit lower value has been obtained because certain number of examinees might not have understood properly the assigned question, so in the future the meaning of the mentioned statement should be clarified and

explained. The obtained results disprove the sub-hypothesis *H1b* that the surroundings of agritourist accommodation units satisfy the criteria to a higher extent in domestic and a lesser extent in international standards, since that hypothesis has been refuted by half of the number of cases (five out of nine cases). When it comes to the observed settlements, farm-based accommodation units in Bezdan, Stari Slankamen and Turija have recorded the highest values for this indicator.

Figure 5 illustrates the results of *Block 3*, where the largest number of maximum values ($N=69$) can be noticed, compared to the other four blocks. It is necessary to point out that as many as five out of nine offered categories have such values, and those categories are: "cleaning services", "meals provided at accommodation", "choice of leisure activities at accommodation", "choice of leisure activities in the surroundings" and "breakfast facilities provided". In all the categories, except the last one ("breakfast facilities provided"), the values are maximal according to both criteria (domestic and

international). The reason for such a phenomenon is explained by the identical criteria, where domestic conditions are equaled to international ones. A very high value is also noticed in the category “access /

signposting” (N=67), but only according to the conditions for domestic market since the criterion is not especially explicit (e.g. basic, non-standardized access and road signs).

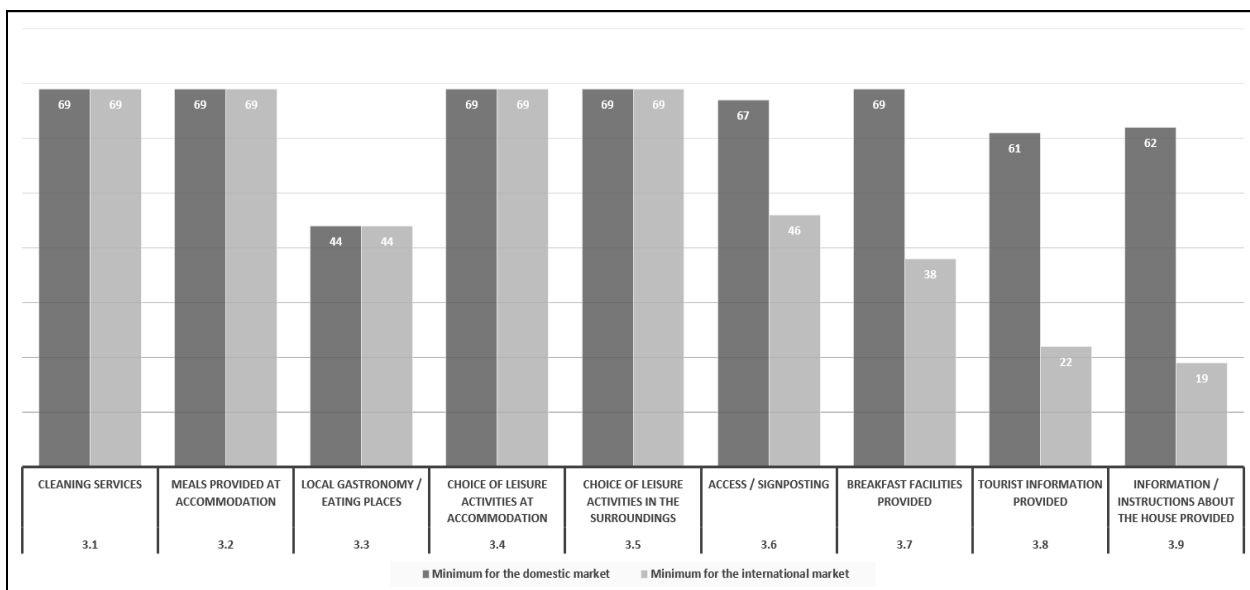


Fig. 5: Overview of the results of achieved standards according to criteria in Block 3 (N=69)

Unlike to these data, in some categories we can notice low values (N=15-29) according to the conditions for the international market and those categories are: “information provided to tourists” (N=22) and “information / instructions provided about the house” (N=19). On the other hand, the values for the conditions for the domestic market are very high in the same categories: “information provided to tourists” (N=61) and “information / instructions about the house provided” (N=62), since in the absolute majority of cases the prevailing information is in Serbian, i.e. the information is meant almost exclusively for domestic guests. This is because a great number of service providers in

farm-stay tourism of Vojvodina have not yet adapted their facilities for the needs and demands of foreign guests, so, in that segment, services should be significantly improved. The obtained results prove the sub-hypothesis *H1c* that the services in agritourist accommodation units meet the criteria according to domestic standards in a great amount, but in a small amount according to international standards, since that hypothesis has been refuted by half of the cases (five out of nine cases). When it comes to the observed settlements, farm-based accommodation units in Donji Tavankut and Totovo Selo have recorded the highest values for this indicator.

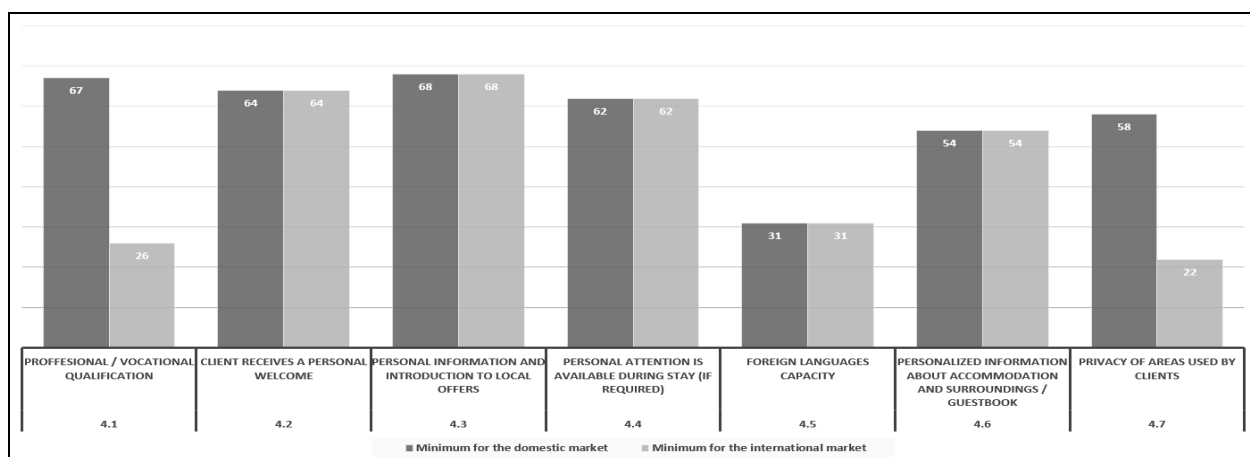


Fig. 6: Overview of the results of achieved standards according to criteria in Block 4 (N=69)

The results of *Block 4* (Figure 6) show very high values ($N \geq 60$) according to both of the criteria in the categories: "client receives a personal welcome" ($N=64$), "personal information and introduction to local offers" ($N=68$) and "personal attention is available during stay (if required)" ($N=62$). The reason for equal answers is, as in previous cases, the identical conditions for domestic and international market assigned by *EuroGites* standards. According to the conditions for the domestic market, a very high value is also recorded in the category "professional / vocational qualification" ($N=67$), since it is not necessary to do additional trainings, as for the international market, where the value in this category is low ($N=26$).

Similar to the previous one, the low value for the international market is also noticeable in the

category "privacy of areas used by clients" ($N=22$), because of much more demanding criteria in comparison with the domestic ones (rooms, bathrooms and other rooms meant exclusively for guests). Since the obtained results show the commitment to a guest, privacy and atmosphere in the agritourist accommodation units largely meet the criteria according to domestic standards, but to a lesser extent in a smaller amount according to the international standard (in two out of seven cases) sub-hypothesis *H1d* is accepted. When it comes to the observed settlements, farm-based accommodation units in Banoștor, Ruski Krstur and Stapar have recorded the highest values for this indicator.

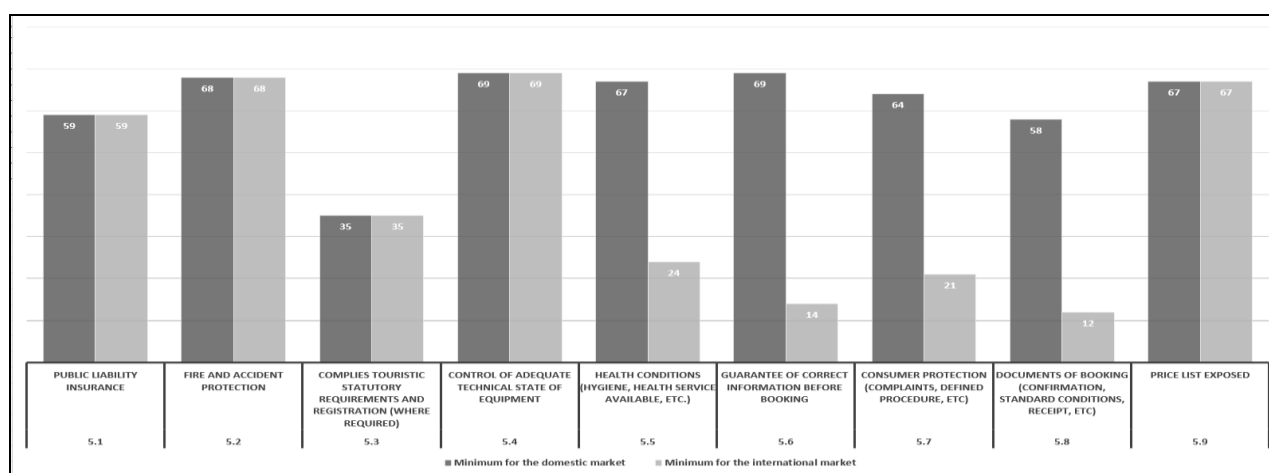


Fig. 7: Overview of the results of achieved standards according to criteria in *Block 5* ($N=69$)

In the Figure 7, it can be noticed that extremely high values, according to both criteria, are noticeable in categories: "control of adequate technical state of equipment" ($N=69$), "fire and accident protection" ($N=68$) and "price list exposed" ($N=67$). Extremely high values according to the conditions for the domestic market are also recorded in the categories: "health conditions (hygiene, health service available, etc.)" ($N=67$), "guarantee of correct information before booking" ($N=69$) and "consumer protection (complaints, defined procedure, etc.)" ($N=64$). It is interesting to mention that precisely in these three categories low indicators appear when the conditions for the international market are concerned. Thus, the categories: "health conditions" ($N=24$) and "consumer protection" ($N=21$) show low values, while the category "guarantee of correct information before booking" ($N=14$) records a very low value. This phenomenon is the result of wider and more rigorous conditions and guarantees that they must comply for this criterion (e.g. detailed information

about health care services in the circle of 15-minute drive, available on demand when making a reservation and absolute availability in the accommodation during a stay, as well as the guarantees from the third person about the accurate information before reservation, an obligatory questionnaire about the consumer's satisfaction etc.). Along with these categories, the category "documents of booking (confirmation, standard conditions, receipt, etc.)" also shows a very low value ($N=12$) for the international market, which is, at the same time, the lowest value in the observed blocks. Such a result is explained by the fact that besides the standard reservation, an available written confirmation about the reservation is also demanded, as well as about the conditions and details of the contracted service, which is not demanded by the domestic market according to this criterion. The obtained results disprove the sub-hypothesis *H4e*, since the security in agritourist accommodation units partially equally and partially in a higher amount satisfies the criteria according to

the domestic standards than according to the international ones (four out of nine cases). When it comes to the observed settlements, farm-based accommodation units in Velebit and Kovilj have recorded the highest values for this indicator.

Conclusion

The quality of farm-stay tourism is measurable by comparing how well the requirements have been fulfilled on domestic and international levels, which makes the main hypothesis (H1) partially confirmed (+/-). Considering that the sub-hypotheses in all cases have been partially confirmed, a more thorough conclusion is as follows:

Sub-hypothesis *H1a* is confirmed (+), since the equipment in agritourist accommodation units to a certain extent satisfies the domestic requirements more than international ones (nine requirements), and to a certain extent satisfies both requirements (10 requirements).

Sub-hypothesis *H1b* is refuted (-), by concluding that the surroundings of the accommodation units to a certain extent satisfies domestic requirements more than international ones (five requirements), and to a certain extent satisfies both requirements (four requirements).

Sub-hypothesis *H1c* is accepted (+), since service in agritourist accommodation units satisfy domestic requirements more than international ones (four requirements), and to a certain extent satisfies both requirements (five requirements).

Sub-hypothesis *H1d* is confirmed (+), since commitment to each guest, privacy and the atmosphere in the agritourist accommodation units to a certain extent satisfies domestic requirements more than international (two requirements), and to a certain extent satisfies both requirements (five requirements).

Sub-hypothesis *H1e* is disproved (-), since safety in agritourist accommodation units to a certain extent satisfies domestic requirements more than international ones (four requirements), and to a certain extent satisfies both requirements (five requirements).

According to everything stated, it can be concluded that the world trends in quality in farm-stay tourism strive towards the needs and motives of modern population for the standardization and expected level of accommodation offer in rural settings. In such a tendency, farm-stay tourism represents an important travel market segment, and by obeying the rules of sustainable development and by cherishing local tradition and culture, this aspect of tourism is becoming one of the strategic and most efficient ways of future development of rural areas.

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Authors' contribution

Marko D. Petrović – field reseraching, results analysing, final text preparation

Aleksandra Terzić – field researching and methodological instrument researching and writing

Ana Jovičić Vuković – theoretical background

Aleksandra Vujko – results analysing and methodological writing

Jovana Brankov – field reseraching

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Cultural Routes – Cross-border Tourist Destinations within Southeastern Europe

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Abstract

Cultural routes may become interesting tourist destinations because of their thematic and traveling experience, making connections to renown places, events and personalities. The process of forming cultural routes as tourist products is considered a new principle of protection, revitalization, use and presentation of cultural heritage. Europe in particular is rich in cultural heritage originating from different historical epochs. This is why within the renown and most visited cultural routes were formed in Europe. There are 32 pan-European cultural routes, of which several routes cross Southeastern Europe. This article aims to examine the interrelation of the cultural routes within Southern Europe with those from the entire Europe. The main goal is to determine to what extent their connection to the existing routes contribute to the tourism promotion of SEE states, making them the cross-border tourist destinations.

Keywords: *cultural routes, tourism, destination, Europe, South East Europe*

Rezumat. Rutele culturale – destinații turistice transfrontaliere în Europa de Sud-Est

Rutele culturale pot deveni destinații turistice interesante datorită experienței tematice și de călătorie pe care o propun, făcând legătura între locuri, evenimente și personalități faimoase. Procesul de individualizare a rutelor culturale ca produse turistice este văzut ca un nou principiu pentru protecția, revitalizarea, utilizarea și prezentarea patrimoniului cultural. Europa dispune de un vast astfel de patrimoniu, ce datează din diferite perioade istorice. Prin urmare, și cele mai cunoscute și vizitate rute culturale se află în Europa. Există 32 de rute culturale pan-europene, dintre care unele traversează și Europa de Sud-Est. Lucrarea de față își propune să analizeze legăturile dintre rutele culturale din Europa de Sud-Est cu cele din restul continentului. Principalul scop este acela de a determina în ce măsură legătura acestora cu rutele deja existente contribuie la promovarea turismului din statele din Europa de Sud-Est, transformându-le în destinații turistice transfrontaliere.

Cuvinte-cheie: *rute culturale, turism, destinație, Europa, Europa de Sud-Est*

Introduction

The cultural itineraries are located on different levels, from local to transcontinental. Their main force becomes the networking of the territories, so that the path is divided into sub-nets and the networks into sites with a common coherence. The research of this common coherence and continuity is significant in terms of image and visibility of the route and the destinations. The thematic paths are focused on the attractions that are organically part of the geographic space, marking the uniqueness and individuality of the territory and linking sites with similar elements (Zabini, 2012). Since cultural routes appeared, in the 1980's, their popularity is constantly growing. They are placed into a context of a visit to a greater number of destinations, expanding to whole regions, countries and even international space. Combination of the cultural exchange and social values are creating the recognizable identity for each cultural route. Even though their main concept is not primarily focused on the tourist use, they represent, beside the cultural dimension, a tourist product as well. Cultural routes have proven to be an extraordinary opportunity for the tourism development in

underdeveloped regions that have valuable cultural or natural resources (Meyer, 2004, Terzić et al., 2014).

The Council of Europe (2006) defines Cultural Corridors as: *"Networks of interaction and economic exchange based on culture and creativity, incorporating principles of sustainability, fairness and inclusion, based on wide stakeholder partnerships which are rooted in solid institutional frameworks that stimulate regional socio-economic development."* The basic idea is to create networks which move beyond physical routes linking cultural sites to include the full range of creative assets in a region (Richards, Russo and Grossman 2008).

Based on the global trend, the number of cultural routes, cultural districts, corridors and itineraries (Di Pietro et al., 2014) in the world is growing. These concepts were developed in Western Europe (Italy, France), considering that Europe has the richest cultural heritage and that it is the most visited destination of the so-called "cultural tourists" (Terzić et al., 2014). Creativity in tourist production and consumption opens the door to a variety of themes, activities, experiences, combined with different levels of involvement and participation of tourists. In the range of products designed to establish a

partnership between tourism and the cultural sector, itineraries connected to cultural heritage are considered an effective means of generating positive effects, and they have therefore gained a central role in local tourism development policies (OECD, 2009).

Over the past decade, cultural routes have been established as an attractive, flexible and extremely effective means of developing cultural tourism products. The cultural corridors are a keystone of tourism, as they enrich the travelers' experience thanks to a wide variety of attractions along a thematic route. These new tourists are motivated by special interests, less oriented to touristic packages, but rather in search of experiences and emotions. In this context, it seems clear that the itinerary becomes an excellent form of cultural tourism as a response to a new postmodern tourist's request. Connections and corridors imply "multiple-destinations itineraries", which a tourist may define as journeys through various regions in one or more countries. This requires cooperation strategies between the regions concerned. In this case, competition gives way to cooperation, allowing each destination to cooperate in building a better tourist product according to a holistic view from which everybody can benefit. The combination of cultural itineraries and tourist creativity could strengthen the local brand, encouraging the improvement of territorial space and the creation new networks (Gallucci, 2007; Messineo, 2012). Throughout this process, tourism products related to cultural routes, cultural cities and cultural must-do's – those which are connected to popular culture, arts, the search for authenticity of destinations and local cultures, are probably the core elements forming the basis of the new scenario of worldwide cultural tourism (UNWTO, 2015).

Cultural routes of the Council of Europe

The Cultural Routes Programme was launched by the Council of Europe in 1987. In 1998, the Council of Europe entrusted to the European Institute of the Cultural Routes the task of monitoring the Cultural Routes programme as a whole. The World Heritage Committee Board approved cultural route initiative at the World Heritage Conference "Routes as cultural heritage" (Madrid, 1994) and acknowledged the concept of routes as an important step forward on the path to the recognition of the diverse nature of mankind's heritage. "A heritage route is composed of tangible elements of which the cultural significance comes from exchanges and a multi-dimensional dialogue across countries or regions, and that illustrate the interaction of movement, along the route, in space and time" (UNESCO, 2004). European cultural routes can be classified

based on geographical model as national, regional and pan-European ones. In order to achieve the certification, it should meet some basic conditions: focus on a theme representative of European values common to several European countries; follow a historical route or a newly created thematic route; give rise to long-term multilateral co-operation projects in priority areas (scientific research; heritage conservation and enhancement; cultural and educational exchanges; contemporary cultural and artistic practices; cultural tourism and sustainable development); be managed by one or more independent, organized networks (in the form of an association or a federation of associations) (www.coe.int/routes).

The creation of cultural routes opened the possibilities for long term multilateral projects of cooperation in the cultural heritage promotion between neighbouring countries in Europe. The programme also started some significant initiatives in the protection of natural and cultural heritage resources, and promoted the sustainable development of Europe. It became the instrument for comprehension of the common European values and interpretation of these values based on rich heritage and interconnections between different regions, communities and historical flows in Europe. The financial gain achieved based on cultural route programmes is placed in function of social, economical and cultural development of Europe for more than a decade. The Cultural Routes of the Council of Europe are also in line with the key trends of cultural tourism development in Europe today. It shows that people can be interested in the protection of cultural heritage and natural resources and environmental management, by creating special interest tourist destinations (The European Institute of Cultural Routes, 2012). They have achieved a noteworthy impact and progress and shown enormous potential for SME generation, clustering, networking (intercultural dialogue) and promoting the image of Europe. Transnational networks and accessibility to different levels of funding – European, national, regional and local, are viewed as the foundation for the Cultural Routes' success.

As there is a variety of cultural routes, there was a need to simplify the grouping of variables in order to arrive at a proposal of cultural routes as a tourism product that is as streamlined and functional as possible. Consequently, some categories can be defined, and routes can be generally classified on several manners (UNWTO, 2015):

- Classification based on their design and structure - There can be linear model of destinations with defined starting and ending point, such as Santiago de Compostela cultural route. However, it can be formed as network model with no defined sequence of connections between points. The visits

can be started or ended at any place of the defined route.

- Classification based on the general theme – Here we have cultural routes that are articulated around the main theme (Transromanica, ATRIUM), but there are also cultural routes which include several topics, with the route itself being the essential theme. Thus, they include the entire natural, heritage, historic and identity resources located near the route or the destinations forming it (Via Regia, El Legado Andalusi, etc.).

- Classification of cultural routes based on their territorial scope – There are five types of routes based on this classification: local, regional, national, transnational (several states) and international (worldwide).

- Classification of cultural routes based on their historic origin or their current reconfiguration – Even though generally all routes must have a well-founded historical basis (Route of Saint Olaf, Santiago de Compostela), some are created based on different “more fictional” representations of

actual historic situation, or based on a theme of a common narrative, rather than the strict historic act (Routes of the Olive Tree, European route of thermal towns).

- Classification based on the visitor infrastructure, classifies routes based on the number and type of overnight stays necessary to visit them. There are routes where overnight stays are not necessarily, those that can be visited with only one overnight stay, and finally routes involving an overnight stay in several places.

Since 1987 until 2016 the 32 Pan-European cultural routes were established and certified, covering 53 countries, and the number is growing (www.coe.int/routes). Different themes that illustrate European memory, history and heritage, also contribute to an interpretation of the diversity of present-day Europe. The classification according to theme is partly applied on the example of certified Cultural Routes (Table 1).

Table 1: Classification of Cultural Routes of Council of Europe

Cultural Route	Year	Theme	Territory
Santiago de Compostela	1987	Pilgrimage	BE, FR, IT, CH, DE, LU, PT, ES
Hansa Routes	1991	Trade Historic	DE, BE, EE, FI, LV, LT, NL, NO, PL, RU, SE, UK
Viking Routes	1993	Historic	UK, BY, BE, DK, EE, FI, FR, DE, EL, IS, IE, LV, LT, NL, NO, PL, PT, RU, ES, SE, TR, UA
Via Francigena	1994	Pilgrimage	IT, FR, CH, UK
El legado Andalusi	1997	Artistic	ES, PT, IT, MA, TN, EG, LB, JO
Phoenicians' Route	2003	Historic Navigation	IT, HR, MT, CY, EL, TR, FR, PT, ES, DZ, LY, TN, MA, LB, SY, UK
Pyrenean Iron Route	2004	Industrial	ES, FR, AD
Route of Jewish Heritage	2004	Historic Pilgrimage	BE, BA, HR, CZ, DK, FR, EL, HU, IT, LT, NL, NO, PL, RO, RS, SK, SI, ES, SE, CH, UA, UK, AT, BG, GE, DE, IE, LU, PT, TR
Mozart Ways	2004	Artistic	AT, DE, BE, FR, IT, CH, NL, SK, CZ, UK
Routes of Olive Tree	2005	Landscape Trade	AL, DZ, BA, CY, HR, EG, FR, EL, IT, IO, LB, LY, MT, MA, PT, RS, SI, ES, SY, TN, TR
St. Martin of Tours	2005	Pilgrimage	AL, AD, AT, BA, BE, BG, HR, CY, CZ, DK, EE, FI, FR, DE, EL, HU, IS, IE, IT, LV, LI, LT, LU, MT, MD, MC, ME, NL, NO, PL, PT, RO, RS, SK, SI, ES, SE, CH, MK, UA, UK
Cluniac Sites in Europe	2005	Pilgrimage	FR, BE, DE, IT, HU, CH, ES, UK, PT, PL, IL
Via Regia	2005	Historic	DE, BY, BE, FR, LT, PL, UA, ES
Transromanica	2007	Architecture	DE, AT, FR, IT, PT, RS, RO, ES
Iter Vitis	2009	Landscape	IT, AM, AT, AZ, HR, FR, GE, DE, EL, HU, MT, MD, PT, RO, SI, ES, MK
Cistercian Abbeys Route	2010	Architecture	FR, BE, CZ, DK, DE, IT, PL, PT, ES, SE, CH
Saint Olav Ways	2010	Pilgrimage	NO, DK, SE
Historic Thermal Towns	2010	Historic Landscape	IT, DE, BE, HR, FR, ES, HU, UK, CZ, RO, TR
Prehistoric Rock Art	2010	Artistic	ES, PT, FR, IT, IE, NO
European Cemeteries	2010	Historic	IT, AT, BIH, DK, EE, FR, DE, EL, IE, NO, PL, PT, RO, RU, RS, SI, ES, SE,

			UK
European Ceramics Route	2012	Artistic	FR, DE, IT, NL, PT, ES, UK
Casadean Sites	2012	Pilgrimage	FR, BE, ES, IT, CH
Megalithic Culture Route	2013	Historic	DK, DE, NL, SE, ES, PT, UK
Huguenot & Waldensian trail	2013	Historic Religious	DE, FR, IT, CH
Réseau Art Nouveau	2014	Artistic	AT, BE, FI, FR, IT, LV, NO, SI, ES, UK, HU, RO, RS, CH, DE
Via Habsburg	2014	Historic	AT, CH, DE, FR
ATRIUM - architecture of totalitarian regimes	2014	Architecture	IT, BiH, BG, HR, EL, RO
Destination Napoleon	2015	Historic	FR, IT, BY, BE, HR, CZ, DE, EL, PL, PT, RU, ES, UK
Roman Emperors & Danube Wine Route	2015	Historic Landscape	RS, BG, HR, RO
Emperor Charles V Route	2015	Historic	DZ, BE, DE, IT, MA, NL, PT, ES, TN
In the Footsteps of Robert Louis Stevenson	2015	Landscape Artistic	FR, BE, UK
Fortified Towns of the Greater Region	2016	Historic Architecture	DE, FR, LU

Among the cultural routes there are not yet certified are: The Heinrich Schickhardt Route, Wenzel and Vauban Routes of Military Architecture in Europe, Route of the Castilian Language in the Mediterranean, Migrations Routes, Parks and Gardens Landscape, Via Carolingia, Rural Habitat in Europe, Saint-Michel Routes, Don Quixote of La Mancha, etc. At the latest nomination list (2016) new themes were promoted: Cultural Route of Saints Cyril and Methodius, The European Places of Peace, Saint Coloman Route, Touring Le Corbusier's utopian living, Routes of St Augustine, Longobard Ways across Europe, The Chocolate Way, etc.

The study that was conducted by the Council of Europe that followed a survey of 29 certified Cultural Routes with goal of gathering current qualitative and quantitative data and information in order to assess the overall development potential of the Cultural Routes programme. Established in 1987, the Cultural Routes programme of the Council of Europe comprises 29 certified Routes with many more in the development state covering 70 countries on four continents (Kseniya Khovanova-Rubicondo, 2012). The study outlined the great potential and essential importance of cultural route programmes in networking, cooperation and SME development process, especially in educational, cultural and tourism sectors.

According to the Figure 1, as previously indicated, the Cultural Routes programme of the Council of Europe comprises 29 certified Routes (by 2012). Some routes extend into other countries beyond Europe's borders, especially Mediterranean and Arab countries— for example the Omeyan Route

of the Legacy of al-Andalus (1997), the above-mentioned Route of the Phoenicians, or the Olive Tree Routes (2005)—and countries in America— for example the Viking and Norman Route (1993) and the Réseau Art Nouveau Network (2014) (UNWTO, 2015) Statistical analysis of the data demonstrates visually the density of the Cultural Routes networks.

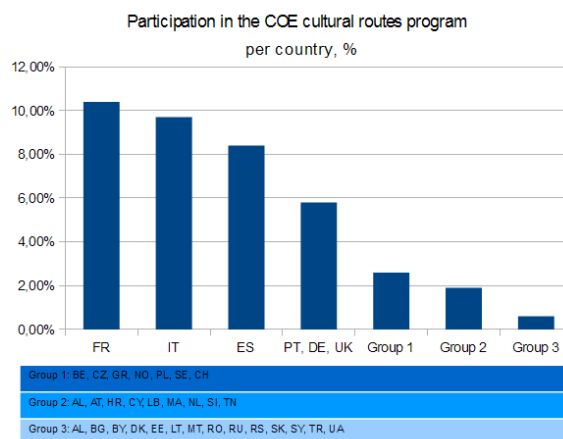


Fig. 1: Participation in the Cultural routes program of Council of Europe (source: www.coe.int, 2012)

It illustrates the share of the Routes network by country: France (10.4%), Italy (9.7%), Spain (8.4%), Portugal (5.8%), Germany (5.2%) and Great Britain (5.2%). The rest of the countries each comprise 2.6% or less. These nations form three large groups, which represent the unexploited development potential of the Council's Cultural Routes programme (Kseniya Khovanova-Rubicondo, 2012). As about 45% of total cultural sites incorporated into the route's network originate from

only 6 countries, it becomes obvious the role they have in general governance issues concerning the cultural route creation and management process. Although highly diffused and decentralized in their way of working, an established network (with a legal structure) often require a node or pivotal point which is identifiable as its centre, the network co-ordination office or secretariat is often essential to undertake the day-to-day administration. Several studies suggest that in many cases the geographical location of the key decision maker is also the key location of the route headquarters (Figure 2), pointing to the strong centralization of the route management within Western European countries. Only two centers are located in SEE region, namely the headquarters of the Route of the Olive Tree located in Kalamata (Greece) and the Roman Emperors and Danube Wine Route, located in Belgrade (Serbia).



Fig. 2: Headquarter's distribution of the Cultural Routes of Council of Europe (source: <http://culture-routes.net/cultural-routes/interactive-map>)

Cultural routes of Southeastern Europe

Southeastern Europe is a geographical region of Europe, expanding primarily on the Balkan peninsula, spreading over 666,700 square km. Geographically, this region is bordered by four seas (the Adriatic, the Aegean, The Sea of Marmara and the Black Sea), three rivers (the Danube, the Soča and the Sava) and by two straits (the Bosphorus and the Dardanelles), but historically, its northern frontier stretched as far as the Carpathians Mountains (Okey, 2007; Terzić et al., 2015). From the administrative point of view, it includes several

states – Greece, Macedonia, Serbia, Montenegro, Bosnia and Herzegovina, Bulgaria, Albania, but also some small parts of Croatia (land between Kupa and Sava rivers), Slovenia (Primorska, Notranjska and Dolenjska region), Romania (Northern Dobrogea), Turkey (East Thrace), Cyprus and Italy (Provinces of Trieste and Gorica). This is a multicultural, multi-ethnic and multi-confessional area, the borders of which are determined differently in scope of geographical, historical, demographical or sociological approach. Southeastern Europe has been a real crossroads of civilizations and religions throughout the centuries; a mediator between the East and the West, the North and the South, transpierced by internal connections and influences, bound up by common historical routes (Terzić et al., 2015). Hence, cultural corridors in the region have been formed, and they could represent trans-national axes of regional interactions and the living memory of the civilizations and connections between nations of this region.

Certain branches of pan-European cultural routes of the Council of Europe are trespassing the South-Eastern Europe's territory, such as: *The European Route of Jewish Heritage*, *Transromanica*, *Atrium - on the architecture of totalitarian regimes of the 20th century*, *European Route of Cemeteries*, *Iter Vitis Route*, *Route of Historical Thermal Towns*, *Olive tree Route*, *The Réseau Art Nouveau Network*, *Roman Emperors and Danube Wine Route*, etc. The branches of these routes expand to SEE countries, and are interconnected to the SEE cultural corridors. However, SEE countries only have a modest share in site participation in the cultural route networks (Figure 3).

The headquarters of most of these routes are located within Western Europe, and the proper management of the route usually doesn't reach these destinations, as the management system of the cultural routes are predominately centralized. Furthermore, the initiative of the creation of the Cultural Corridors of South East Europe is a project implemented by the Association for Cultural Tourism in collaboration with the European Institute of Cultural Routes. It is part of a macro-regional project for South-East Europe as promoted by the Council of Europe, the European Commission, UNESCO, ICOMOS and other institutions. The Pilot Project "Cultural Corridors – Analysis to Synthesis" is implemented as part of the Regional Programme for Cultural and Natural Heritage in South East Europe 2003-2008.

The initiative nested several SEE cultural development projects: The Children and the Cultural Heritage of South East Europe, 2005-2006, the Website Cultural Corridors of South East Europe, 2006, the Exhibition at the Regional Forum "he

Trans-Balkan Cultural Corridor", 2007 and Heritage: ESPRIT, 2007-2008.

SEE countries	Number of routes	CERTIFIED CULTURAL ROUTES
ROMANIA	9	European Route of Jewish Heritage, ATRIUM, Iter Vitis Route, Transromanica, St. Martin of Tours Route, Via Habsburg, Réseau Art Nouveau Network, Via Habsburg, Réseau Art Nouveau Network, Roman Emperors and Danube Wine Route
CROATIA	10	Phoenician's Route, European Route of Jewish Heritage, European Cemeteries Route, Olive Tree Route, ATRIUM St. Martin of Tours Route, Iter Vitis Route, Route of Historical Thermal Towns, Destination Napoleon, Roman Emperors & Danube Wine Route
GREECE	8	Viking Routes, Phoenician's Route, Olive Tree Route, Iter Vitis Route European Route of Jewish Heritage, European Cemeteries Route, Route of Historical Thermal Towns, Destination Napoleon
SERBIA	5	European Route of Jewish Heritage, Transromanica, European Cemeteries Route, Réseau Art Nouveau Network, Roman Emperors and Danube Wine Route
BULGARIA	3	European Route of Jewish Heritage, ATRIUM, Roman Emperors & Danube Wine Route
BOSNIA & HERZEGOVINA	2	European Route of Jewish Heritage, European Cemeteries Route
CYPRUS	2	Phoenician's Route, Olive Tree Route
ALBANIA	1	Route of the Olive tree
MACEDONIA	1	Iter Vitis Route
MOLDOVA	1	Iter Vitis Route

Fig. 3: Pan-European cultural routes of the Council of Europe within SEE (source: Council of Europe, 2016)

The project promotes the development of several Cultural routes:

- the Danube Road as fluvial cultural corridor along the Danube River;
- the Diagonal Road (Via Diagonalis, Via Militaris, Carigradski drum, Via de Ragusi in the region of Croatia, Bosnia and Herzegovina, Serbia and Montenegro);
- the Eastern Trans-Balkan Road, connecting important monastery centers and the cultural route Via Regia (the Royal Road) in Ukraine;
- the cultural corridor Sofia-Ohrid, passing through Bulgaria and FRY Macedonia and connecting the monastery agglomerations and the churches;
- Via Adriatica, spreads over the western seaboard of the Ionian and Adriatic seas, and symbolizes the exchange among the Aegean, Roman, Byzantine, Dalmatian and west European civilisations, joining the Saint James' Way and Saint Martin cultural route;
- Via Anatolia is connecting two unique cultural centers: Istanbul and Antakya (former Antioch), where it meets the branch of the Silk Road coming from Esia, and crosses a Bronze age sea trade Route known as Via Maris;
- Via Egnatia is an ancient Roman road, facilitating communication between Rome and Constantinople (present-day Istanbul). It was important for the dissemination of Orthodox

Christianity in SEE and, later on, Islamic domination. It also links to the Via Francigena, Route of the Castilian Language and the Sephardic Routes.

- Via Pontica is spreading over the south-west coasts of the Black Sea, from the Danube Delta to the Caucasus, crossing Romania, Bulgaria and Turkey.

- the Western Trans-Balkan Road is connecting western and central Europe with the Aegean and the Mediterranean seas, crossing consecutively the Danube Road, the Diagonal Road, the Sofia-Ohrid Road and Via Egnatia (Council of Europe, 2012).

The list of the most representative sites of each corridor are included and presented on the lists and maps on the official website (<http://seecorridors.eu/>). However, the cooperation of destinations presented is still underdeveloped, such as the joint activities between neighboring regions. Present state of cultural heritage in Southeastern Europe is fragmented in closed national and local systems, not considered in the existing transnational cultural corridors. In most cases these unique cultural values linked to cultural corridors, are little known in Europe, in the world, and even in the region itself. The fragmentation of the cultural tourism market only in local frameworks of individual countries or municipalities will have partial and incomplete effect in which the majority

of cultural resources will remain unknown and inaccessible (Shishmanova, 2015).

The cross-border cooperation in SEE region, considering heritage preservation and promotion is usually financed under several IPA CBC funds. A number of projects include natural and heritage promotion and the creation of regional tourist offer, such as: project financed through the South East Europe Transnational Cooperation Programme: ATRIUM cultural route, Extension of the Danube Limes - UNESCO World Heritage in the Lower Danube, SY_CULTour – Synergy of culture and tourism, Cultural (Garden) heritage as focal points for sustainable tourism, CULTEMA, CHERPLAN - Enhancement of cultural heritage through environmental planning and management, BanaTour and Banats cultural patrimony project (Romania – Serbia), Thematic Routes of DKMT Euroregion (Hungary- Serbia -Romania) – Secession Routes, Folklore without borders, „Wandering In The Pantry Of The Monarchy“, Recreation without borders – wellness/health tourism, Tasty DKMT – gastronomy route; The natural resources of the cross-border region – new destination for balneological and spa tourism (Bulgaria – Serbia – Romania), Legends as a tourism enforcing instrument in the region Kula-Zaječar-Vidin, Cultural events network, Revitalization of Golubac and Vidin fortress, "In Search for Economic Reviving and Development: Preparation for Joint Promotion of the Cross-Border Region Business Potential" (Bulgaria – Serbia) etc.

Anyway, the process of creation cultural routes and corridors within national and regional scope in SEE is expanding, and the new cultural/thematic/tourist routes are appearing fast. For example, in 2013, the cluster of cultural routes in Serbia was founded (cluster-culturalroutes.org), as a non-profit organization with a goal to promote Serbia and the Balkans as a cultural tourism product through specific routes such as The Valley of the Dragons - mythological heroes of Balkans epic culture, The Nikola Tesla and Stanojević Ways (Serbia, Croatia, Slovenia) and The Mining Route – The Balkans as a Cradle of Metallurgy (Graf, 2013). In Romania two interesting initiatives of creating cultural routes were evidenced - the Transhumance Route project (initiated in 2014 by Sibiu County Tourism Association for Marginimea Sibiului Area) and the Route of Fortified Churches, a highly potent theme of the architectural heritage, poorly harnessed so far (Oprică, 2015). Similar actions were noted in Bulgaria, Croatia (Golden Threads Road – rural tourism route in Slavonija, 2015), Bosnia and Herzegovina, Montenegro, Macedonia, Albania etc. Some of them are already functioning as a destination for cultural tourism, even though not exploited to their full potential.

The promotion of these sites through the constant promotional activities of the Council of Europe, different international organizations, national tourist organizations and joint websites is ensured. However, the actual tourist product for cultural corridors of SEE is still undeveloped. With offering only restricted information, usually through websites and brochures, without direct contact and information on visitation possibilities, tourist programs and existing tourist infrastructure, the sustainable tourism development of cultural corridors is questionable. Potential visitors are left to acquire information and organize their own trip, with no real clue what to expect on destination upon actual arrival. On the other hand, Cultural Routes of Council of Europe offer much more information for potential visitors and even offer full tourist programmes including accommodation, food, guiding services, visiting tickets to museums and festivities, free souvenirs, guidebooks and promotional materials (for a price of 89 EUR per night/destination on the Hansa Route).

Discussion

Despite the Resolution CM/Res (2010) on the rules for the award of the "Cultural Route of the Council of Europe" certification, stating that the networks should "operate democratically", in a number of cases the Cultural Routes are dominated by a single member albeit within the framework of an association and are only nominally operating in a democratic fashion. New route themes need to be common for at least three European countries, they must bring forward opportunities for renewed cultural and educational exchange and need to aim at developing new touristic products and events within sustainable development scope. Both subscriptions to existing routes and new route proposals need to demonstrate multidisciplinary and multiorganizational involvement, and to undertake rigorous research and evaluation steps before making official proposal to the Council of Europe.

The process of application is lengthy and once approved, the registered site usually commits to paying an annual membership fee (that vary from route to route). According to the initial survey carried out by the Council of Europe in 2012, 14 of the 29 Cultural Routes collect some sort of membership fee or receive funding from a range of city authorities (from 70 euro/year for *The Viking Route*, 300 euro/year for the *Route of European Cemeteries*, reaching up to 1000 euro/year per destination on *Iter Vitis* route and *Transromanica*, to even 4000 euro/year for *The Route of Prehistoric Rock Art*) (Oprică, 2015). This brings forward an issue of observed interests and benefits for cultural

sites and destinations for applying for the official certificate of Cultural Routes.

The studies (Hospers, 2002; Meyer, 2004; Briedenhann & Wickens, 2004; Jansen-Verbeke, Priestley & Russo, 2008; Khovanova-Rubicondo, 2012; Graf, 2013) show that there is collaboration emerging between the Cultural Routes and tourism sector, in order to develop cultural tourism. Some of the initiatives incorporate the development of interactive guides, links to new audiences via social media, creation of new festivals and events, establishing joint marketing with tour operators, especially hotels and restaurants, gastronomic tourism and agritourism/ecotourism destinations, etc. However, there is still relatively limited articulation between the cultural routes and newly developing themes in cultural tourism. In particular, the types of tourism activities being created by most of the cultural routes seem to have little overlap with some of the main focus of the Council of Europe, such as human rights, democracy, social cohesion and intercultural dialogue (Khovanova-Rubicondo, 2012). One of the aspects of cultural tourism that makes it particularly relevant for the policy of the Council of Europe is its intercultural dimension, as many different cultures are brought together in the development, consumption and communication of cultural tourism. The economic benefit of the investment in the evaluation of protected areas and cultural monuments can be found in the planned inclusion of these areas into the national tourism promotion.

When it comes to a complex tourism products such as cultural routes, it is an absolute necessity to incorporate different institutions (engaged in the field of culture, education), public associations and organizations in the process. Different initiatives and activities should advance the cultural life of a local community and also enrich the tourist offer in various places along the route. Such results can be achieved only with cooperation on multiple levels (Terzić et al., 2014, 2014a). The special interest tourist programmes, such as cultural routes are usually more expensive than prefabricated mass tourism programmes, as they offer high quality, the possibility to choose among a variety of offered items and a specific experience value for each consumer. These programmes, thematically oriented, time-consuming and quite expensive, are attractive for certain consumer groups (rich senior individuals, mostly from Western European Countries). Even though becoming more popular among tourist, it is not likely they will ever become mass tourism products. However, their educational, multicultural, multiethnic and multi-confessional scope could be interesting for youth groups (students), whereas tourist offer should be developed in the form of student exchange

programmes. The prices of such programmes must be significantly reduced or co-funded at the institutional or national/international levels.

Conclusions

The geographical distribution of the cultural routes within European space points out to the potential for the further development of the existing routes, and the incorporation of the Southeastern European destinations into the cultural route networks. The subscription of new sites to existing cultural routes collates with the problems of accommodating unique sites within the domain of generic themes. Clear guidelines by the Council of Europe frame the possibilities for expanding the existing certified routes and for new proposal of routes. Horizontal and equitable governance structuring is a fundamental principal of strong networking. With constant struggle to maintain and preserve heritage sites within Southeastern countries, with only symbolic funds invested in the heritage management and promotion, there is no real interest nor support for the integration of SEE heritage sites to European cultural routes. Certain concrete measures to support the integration are being taken by national authorities and public institutions. Leveling the interests of cultural routes principles and tourism development potentials, enabling certain compromising options, between preservation - utilization (exploitation) sides, could bring the win-win results for both, at local, national, regional or international level. A coordinated tourism management within integrated regional network of cultural tourism products will reveal the full richness of the regional cultural phenomena and would increase the competitiveness of the tourism market in the region as a whole. Regional network of cultural tourism products integrating cultural, tourist and travel information infrastructure for cultural itineraries could create conditions for flexible regulation of tourist flows. The development of new thematic routes gives the outstanding opportunities for the regional cooperation, especially in the underdeveloped regions in SEE. The inclusion of significant funds in the development of cultural routes, demands for cultural heritage to be incorporated into the route and by its revitalization to become more appealing to tourists.

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Foreign Direct Investments in Serbia as a Form of Cross-border Cooperation

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Abstract

The forms of foreign direct investments that represent the instrument of cross-border cooperation are Greenfield and Brownfield investments. On the territory of the Republic of Serbia, during the 2000-2016 period, there were established 151 Greenfield and 15 Brownfield companies. The sum of investments of these 166 companies was near € 7,000,000,000. the capital is from 18 European countries, then from United States, Taiwan, China, South Korea, Canada and India. The largest number of the investments is from Italy (30), Germany (29), Austria (17) and Slovenia (16). Most Greenfield and Brownfield companies belong to the secondary and tertiary sectors of the economy, while 22 companies belong to quaternary sector (real estate, tourism, finance, insurance and pension, telecommunication, film industry, software and ICT).

The analysis, synthesis, comparative and mapping methods were used in this paper. The data were collected from domestic and foreign scientific papers, as well as from the official electronic database. Given data are connected to the traffic network of Serbia, and the goal was to realize its influence on choosing locations for foreign direct investments.

Favourable geo- traffic position of the towns, where the company seats are located, has great significance in the work of these companies due to the reduction of transport costs. This paper analyzed the companies' selection of location and their position in relation to the main roads in the country - Corridor X. The zonation of companies and towns where they are located, depending on their distance from the corridor 10, were processed in GeoMedia program. Results showed that most of the companies (102) were located at a distance of 10 kilometres from the highway.

Keywords: *Greenfield and Brownfield investments, cross-border cooperation, Corridor X, GeoMedia GIS program*

Rezumat.

Investițiile stăine directe în Serbia ca formă de cooperare transfrontalieră

Investițiile de tip brownfield și greenfield constituie principalul tip de investiții străine directe ca instrument de cooperare transfrontalieră. Pe teritoriul Serbiei, în perioada 2000-2016, au fost înființate 151 de firme tip greenfield și 15 brownfield, suma investită a acestor 166 companii totalizând aproximativ 7 bln Euros. Capitalul investit provine de la 18 state europene, apoi din SUA, Taiwan, China, Coreea de Sud, Canada și India. Cei mai mulți investitori provin în Italia (30), Germania (29), Austria (17) și Slovenia (16). Cele mai multe firme de tip greenfield și brownfield desfășoară activități din domeniul secundar și terțiar, în timp ce 22 de firme sunt în domeniul cuaternar (imobiliare, turism, finanțe, asigurări, telecomunicații, industria filmului, software și TIC).

Lucrarea are la baza metoda analizei, sintenței, cartării și comparației, datele fiind obținute din lucrările științifice publicate în Serbia și străinătate, precum și din baza electronică de date oficiale, având în vedere că datele sunt legate de infrastructura de transport a Serbiei, scopul lucrării fiind acela de a evalua modul în care aceasta a influențat localizarea investițiilor străine directe.

Poziția geografică favorabilă a unor orașe în ceea ce privește principalele căi de comunicație are un rol major în localizarea sediilor centrale ale firmelor, datorită reducerii costurilor necesare transportului. Lucrarea de față analizează modul în care firmele au localizat investițiile și poziția acestora față de principalele căi de transport din țară – Coridorul X. Cu ajutorul programului GeoMedia, a fost analizată zonarea companiilor și a orașelor unde sunt acestea situate în raport de distanța până la coridorul X. Rezultatele indică faptul că cele mai multe firme (102) sunt situate la o distanță de 10 km față de autostradă.

Cuvinte-cheie: *cheie: investiții de tip brownfield și greenfield, cooperare transfrontalieră, Coridorul X, GeoMedia GIS.*

Introduction

Serbia is a modern, democratic European country, on the path to the membership of the European Union, and it's the only country outside of the Commonwealth of Independent States that has a Free Trade Agreement with Russian Federation (RAS, 2016). Serbia's tax system is highly conducive to investment, featuring one of Europe's lowest corporate profit tax rates set at 15%, VAT of 20% and 10% salary tax etc. (KPMG, 2014).

Although until the beginning of the World War I, during the last decade of the 20th century, in the former Yugoslavia was a favourable climate for foreign investment, due to the highly developed and export-oriented economy, the scope thereof was

small. The beginning of the 21st century was a period of recovery after the destruction of infrastructure caused by the bombing of Yugoslavia and that was the beginning of the transition economy, from planned economy to the free market. This period was characterized by disappearance of domestic production, so that the domestic market was open and left to foreign investors. Since "globalization and openness to trade, foreign investment and innovation are widely seen as major factors in the post war growth experience" (Barrel, Pain, 1997). National Alliance for Local Economic Development and Airport "Nikola Tesla" started the campaign "Invest in Serbia - the climate is favourable", in 2011. The aim of this campaign was to attract the foreign investors.

Serbia has good traffic position on Balkan Peninsula, between Central Europe and Middle East. Transport infrastructure consists of highways, good connected railways, waterways and air corridors. Highway E-75 connects Norway and Greece, the total length is 5.639 km, of which 374 km pass through Serbia. The main railway through Serbia goes parallel with highway and the other one connect north part of the country with Montenegro. Danube waterway (Corridor 7) connects Western and Central European Countries with South-eastern and Eastern European countries, the total length through Serbia being of 588 km.

"The first regulations on foreign investment in the Yugoslav economy were adopted in July 1967, while more comprehensive foundations for regulating this field were established by the 1971 Constitutional Amendments. In particular, Amendment XXII, Item 4, regulates issues related to the use of foreign investor funds under terms and within scopes laid down by the federal law." (Business info group, 2012).

"FDI are a very important form of financing global economy. Compared to the other two forms of the international movement of capital, loan capital and portfolio investments, foreign direct investments are strongly represented in the financing of the global world economy and national economies of individual countries, especially in the financing of developing countries and countries in transition in which they are a primary form" (Stojadinović, Jovanović, 2013). They are one of the main drivers of economic growth in many countries, particularly in developing countries, where there isn't sufficient domestic capital investment due to the economic crisis. "The global financial crisis has affected, among other things, the decline in foreign direct investment as well as the increase of regional differences, both at global and lower regional levels" (Dašić, 2011).

FDI have positive and negative consequences for the country in which they invest. The positive side of FDI are related to: increasing the number of jobs, lower risks and expenses in relation to taking of loans on the international financial market, increasing the volume of capital and foreign exchange funds by investors, able to generate new knowledge due to training by foreign experts, learning management skills about new technologies, prevents the migration of the working age population, etc. (Begović et al., 2008). "Since multinational firms often use a higher level of technology than the domestic firms, and technology, or knowledge, has certain characteristics of public goods (Markusen, 1995), there is scope for positive externalities and indigenous firms may benefit from these by becoming more efficient" (Barrios et. al, 2004). Negative FDI consequences are related to: the

competitiveness of foreign firms to domestic firms which may lead to their closure, exploitation of resources of the host country, they may voluntarily withdraw from the host country, and thus lead to workers losing their job, a foreign investor acquires the right to control and manage the company in which he invested capital, and have the ability to self-determination on salaries and workers' rights, etc.

Foreign direct investment can be realized in different shapes and implemented in different ways, such as:

- the establishment of a new company (Greenfield investment), a wholly-owned of foreigner through joint ventures;
- taking over existing companies in other country through purchase, recapitalization or by conversion of loans into ownership - swop arrangement (the so-called cross-border acquisitions);
- fusion - the merging companies (cross-border mergers);
- the combination of Greenfield investments and acquisitions (Brownfield investments);
- joint ventures without the right of ownership (i.e. the contractual investment) and
- investment in the form of concessions, B.O.T. system and time sharing.

The paper analyzes a spatial distribution of Greenfield and Brownfield companies, such forms of foreign direct investment, which are established on the territory of the Republic of Serbia in the period from 2000 to 2016. As such, they led to changes in the economic situation of the Republic of Serbia. One of the main differences between Greenfield and Brownfield investment is the level of construction of the area where the investment will be realized. Greenfield investments are usually placed on the previously undeveloped area without infrastructure (green fields), unlike brownfield investments which use existing facilities, that were old, abandoned, poorly used, and therefore they lost the previous function. It is usually the case with industrial plants, military facilities, tourist centres, etc.

The most favourable option for the realization of Brownfield investments are the attractive locations. According to the Swiss model, the best locations for Brownfield investment are lands where prices exceed the necessary investments, as opposed to the location where the value of the land is equal or lower than the necessary investment. In another case, state intervention is necessary through various incentives for investors. "In addition, because the Brownfield is a special form of a foreign acquisition undertaken as part of the establishment of the investor's local operation (Meyer, Estrin, 2001), a firm's foreign Brownfield investment may also encounter hurdles with high transaction costs in the host equity market. However, Greenfield entry can avoid such market transaction costs by reducing

exposure to the host equity market" (Cheng, 2006). The advantage of Brownfield investments is reflected in the beautification of the area, which was abandoned and ruined, and it represented an ugly picture of the city. Brownfield investment gains entirely new revitalization functions, such as recycling and rehabilitation of the area. De Sousa, Wu and Westphal claim that "a key barrier to Brownfield redevelopment is the lack of funding support, and a main barrier to attracting funding is the lack of information about the benefits that Brownfield projects generate" (De Sousa et al, 2009).

Foreign Direct Investments in Serbia

European Union was a favourable area for FDI at the end of the 20th century when „attracted over 40% of total world flows of foreign direct investments, becoming the largest recipient of multinational activity" (Basile et. al, 2008). The volume of FDI was not evenly distributed in all EU countries, but it was favourable because „FDI has been often considered an important way with which to promote the modernization of new entrants to the EU and in the countries considered here it has undoubtedly played a considerable role in this regard, although this has differed across countries." (Barrios et. al, 2004). This can be seen in the case of Central and Eastern European countries that are part of EU. "According to a survey by Ernst & Young, the region including the Czech Republic, Hungary, Poland and Slovakia together with Estonia, Latvia, Lithuania and Slovenia (the other four CEE states which acceded to the EU on 1 May 2004), is now regarded by international executives as the second most attractive place after Western Europe and is the most favourable place for investment in the manufacturing industry." (Allen, Overly, 2006). As for Southern European EU countries Spain, Portugal, Italy and Greece, they "are emerging from a period of uncertainty and have a lot to offer to investors, but the levels of success in attracting FDI vary" however since the reforms have not been implemented yet, "Northern Europe seems to attract more FDI inflows in comparison with the south" (Karadima, 2015). If we consider the volume of FDI in non-EU countries, the situation is quite different. "Although the share of investments coming from non-EU countries is rising, still more than 60% of total inward FDI flows into European countries are intra-EU investments" (Vetter, 2014).

The history of FDI in Serbia was similar to the countries in its vicinity (non-EU countries, except Croatia) due to the process of transition that in the most of Balkan countries was parallel. At the beginning of the 20th century, these countries, , "relied on foreign investors to bring the new capital which would induce economic growth and catching-up, but also improve existing business procedures, update

frequently outdated technology, open new markets, increase the potential for trade, and bring technology and management know-how" (Botrić, 2010).

The focus on foreign direct investments, as potential initiators of redevelopment of the economy, in Serbia was very present just after the year 2000. Thanks to FDI, in the period of 11 years, the revenue was 14.929 billion Euros in total, most of which was by far received in 2006. In that year, the Norwegian company Telenor bought the company Mobtel for 1,513 million euros (SIEPA).

Foreign Direct Investment in Serbia increased by 124 Million Euro in March 2016. Foreign Direct Investment in Serbia averaged 227.73 Million Euro from 1997 until 2016, reaching the all time high value of 3 322.61 Million Euro in November 2006 and a record of the lowest value of -476.61 Million Euro in January 2012. (National Bank of Serbia)

„As part of the competition 'European cities and regions of the future 2012/2013', which is traditionally organised by the Financial Times' FDI Intelligence unit, seven Serbian towns and regions were classified among the top 10 destinations in Europe for different categories related to FDI." (Business info group, 2012).

In Serbia, until 2016 166 companies registered, of which 151 Greenfield and 15 Brownfield companies. The sum of investments of these 166 companies was near € 7,000,000,000. The origin of the capital is from 18 European countries, then from United States, Taiwan, China, South Korea, Canada and India. The largest number of the investments is from Italy (30), Germany (29), Austria (17) and Slovenia (16). Delhaize (Belgium), Telekom Austria Group / VIP Mobile (Austria), Merkator (Slovenia), BIG CEE (Israel) and BIG TIGAR (France) with total investment of 3,040,000,000 Euros (49.2%), represent the first five Greenfield investments in Serbia by the invested money. Among Brownfield investments stand out: Coca Cola (Greece), Tetra Pak (Sweden), Siemens Loher Elektro (Germany), Alumil Milonas (Greece) and DM (Austria) with total investments of 281,000,000 Euros (90.8%).

The project teams of the Ministry of Regional Development and Local Government, Republic Geodetic Authority and "Jovan Cvijić" Geographical Institute SASA created the Development of the solution for Establishing an Integral Business Infrastructure Cadastre in order to inventory of potential locations for Brownfield investment. The design solution in Serbian and summary in English was done in 2013, but has never been implemented.

Data and methods

The database of investments has been taken from National alliance for local economic development. On the website of this organization there are given all

data about foreign direct investments, but for this paper only the data about Greenfield and Brownfield investments were used. For other data of foreign direct investment there was used the available literature cited in the references.

This paper aims at analyzing the spatial distribution of Greenfield and Brownfield companies and their position in relation to the main roads in the Republic of Serbia – Corridor X. Favourable geo-traffic position of the towns, where the company seats are located, has great significance in the work of these companies due to the reduction of transport costs. The zonation of companies and towns where they are located, depending on their distance from the corridor 10, were processed in GeoMedia program.

Results

Analysis of Greenfield and Brownfield investments by year

The number of Greenfield and Brownfield investments in Serbia goes up and down through years, but great increase could be seen in two years – 2007 and 2010. In 2007 the investments were originating from nine countries. The largest number was from Austria (6) then from Italy (5) and Slovenia (5). In that year all twenty-five investments were Greenfield. In 2010 one Brownfield investment was from Germany and twenty-five were Greenfield from twelve countries. By far the largest number of investments was from Italy (8). In second place there was Germany (3 Greenfield and 1 Brownfield), and the third place was shared by Israel (2), the U.S. (2), Slovenia (2) and South Korea (2).

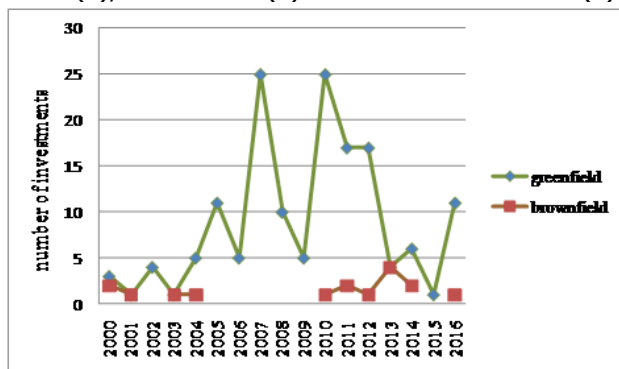


Fig. 1: The number of investments by year (2000-2016)

As shown in figure 1, Brownfield investments are not so frequent and numerous as the Greenfield. During the observed period of 17 years, there were even seven years without this kind of investments.

Analysis of Greenfield and Brownfield investments by areas

From 2000 to 2016, the largest number of Greenfield and Brownfield investments (according to

the investment amount) was in Sremska area (34), which means that every fifth investment is in this area. Belgrade's (Beogradska) area is on the second place with 30 investments, and then there follows Južnobačka (13), Srednjobanatska (12) and Šumadijska (11) areas (Fig. 2). The five mentioned areas occupy 60% of the total number of investment. These five districts occupy 18% of the territory of Serbia.

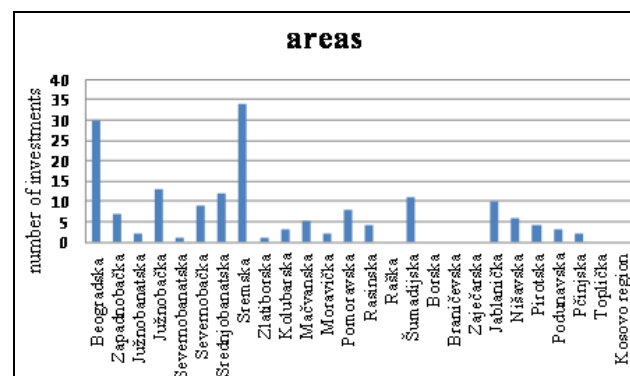


Fig. 2: The number of investments by areas

There are five areas without any investments: Raška, Borska, Braničevska, Zaječarska and Toplička. They belong to the group of underdeveloped areas in Serbia. In Severnobačka area there is only one investment, it is a Brownfield and the amount of the investment is not known. In Zlatiborska area, there is also one investment.

Observed by regions, almost every second investment is in Vojvodina, while the lowest number of investments is in the region of Southern and Eastern Serbia (15%), where the above mentioned 5 areas belong. There are no available data for the Kosovo and Metohija region.

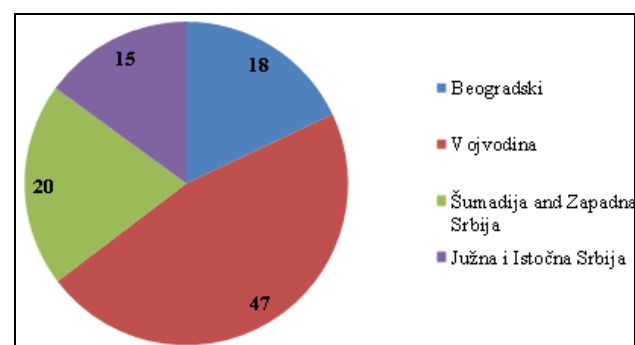


Fig. 3: The number of investments by regions

Analysis of Greenfield and Brownfield investments by the amount

Belgrade area has by far the largest amount of money of Greenfield investments, 3,313,000,000 Euros, which is 55% of all investments from 2000 until now. Južnobačka area is on the second place and occupies 12%, and Sremska and Šumadijska

area are on the third place with 7% and 6%. This means that in these four areas there are 80% of the money of all the Greenfield investments. Zlatiborska area does not have any Greenfield investments, and 8 areas have each 1% of the amounts of the investments (Fig. 4).

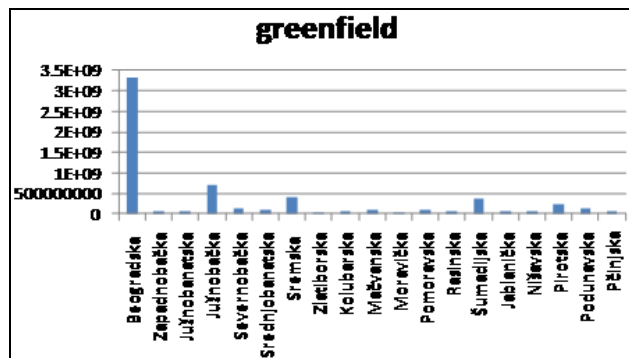


Fig. 4: The analysis of Greenfield investments by the amount

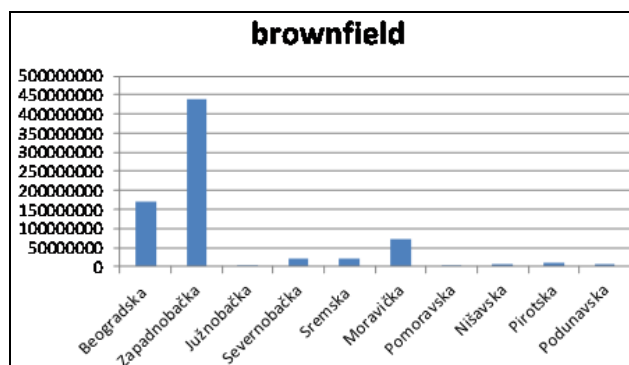


Fig. 5: The analysis of Brownfield investments by the amount

The largest amount of Brownfield investment is 437,000,000 Euros and it's in Zapandnobačka area (Fig. 5). This is 58% of all Brownfield investments. Beogradska area is on the second place with 22% and Moravička area is on the third place with 10% of the Brownfield's money. Two areas have 3% each (Severnobačkai Sremska) and five areas have 1% each (Južnobačka, Pomoravska, Nišavska, Pirotska and Podunavska).

If Greenfield and Brownfield investments are analyzed together, in Belgrade area there is 51%, in Južnobačka area 10%, in Zapadnobačka area 7%, in Sremska area 6%, in Šumadijska area 5% and in Pirotska area 4% of all the money from investments. In thirteen areas is 1-2% and in five there are no investments.

If we consider the total invested money and total population of the 19 areas, we can conclude that the average money per capita is 1,093 Euros. Figure 6 also shows (like the previous analysis) that six areas are above average: Beogradska, Zapadnobačka, Južnobačka, Sremska, Šumadijska and Pirotska. The

reason why the Pirotska area is so much above the average is due to the smallest population and the sixth (of nineteenth) place by amount of investment.

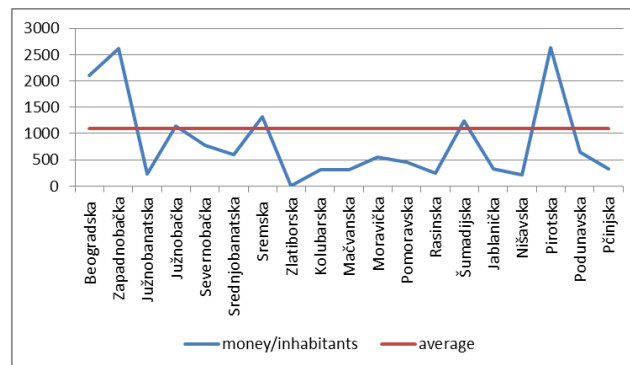


Fig. 6: The area in comparison to the average (money/inhabitants)

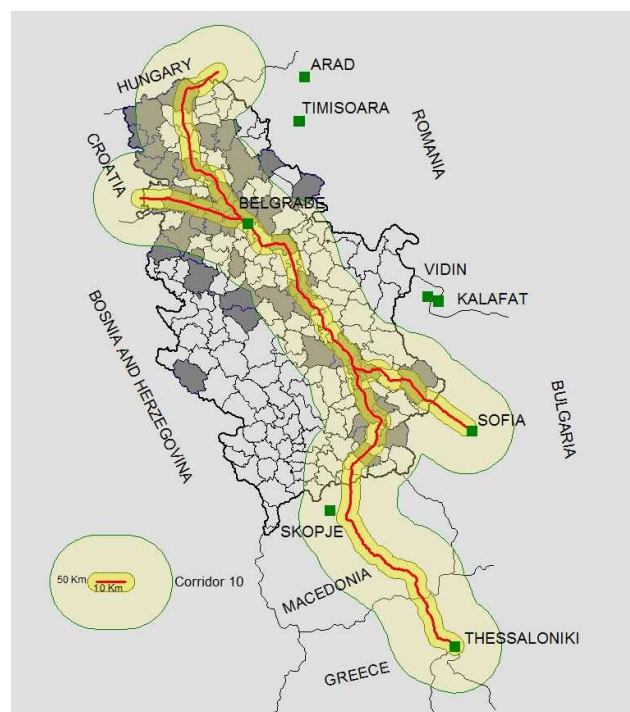


Fig. 7: The map of the buffer zones investment depending on the Corridor 10 (realised by authors, 2016)

Figure 7 shows three buffer zones: First one— 10 km from Corridor 10, second one—from 10 to 50 km from Corridor X, and third one— 50 and more km from Corridor X, the rest of the area. The largest number of investments was located in municipalities that are near the Corridor 10, in fact there are 56% of all municipalities in which Greenfield and Brownfield are invested. And the most of companies, 102 of 161, were located at a distance of 10 km from Corridor X. In the buffer zone, from 10 to 50 kilometres from highway, there are 38% and in the zone which is 50 kilometres and more from corridor 10 there are only 6% of the municipalities.

Discussion and conclusion

Greenfield investments are a characteristic of developing countries, such as Serbia. A positive thing is that the Serbian market is open to this kind of economic cooperation and that European and global economic forces are involved. However, greater competition in form of strong domestic companies is necessary.

From 2010 to 2015, there was a decreased number of Greenfield and Brownfield investment, and also the amount of invested money, but this situation is better in 2016 than during previous three years. Italy, Germany, Slovenia and Austria are the countries that make most of these types of foreign direct investments in Serbia. From the neighbouring countries, three investments were from Hungary in 2005 and 2008, and one was from Bulgaria in 2007.

In Sremska, Beogradska, Južnobačka, Srednjobanatska and Šumadijska areas there are 60% of all the studied investments. On the other side, five areas (Raška, Borska, Braničevska, Zaječarska and Toplička) do not have this type of investments. In Severnjobanatska area there was one Brownfield and in Zlatiborska area there was one Greenfield investment. More than half of invested money goes to Belgrade area. In Beogradska, Južnobačka, Šumadijska and Sremska areas went 80% of money. These four areas and Zapadnobačka and Pirotka areas have invested money per capita more than the average for Serbia (1,093 Euros).

Greenfield and Brownfield investments have a great role in the economy of Serbia, but Greenfield investments are numerous. According to the analysis, the number of those investments by municipalities in most cases, is determined by their geographic position. The fact that 102 of 161 investments (96%) were located at a distance of 10 km from Corridor X, confirms that the main roads are one of the decisive factors when choosing the location for new investment.

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Comparative Analysis of the FDI's Spatial Localization Models in the Danube Provinces of Bulgaria

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Abstract

The Danube provinces of Bulgaria are among the least developed NUTS3 regions in the country and in the EU. From that point of view, overcoming of their socio-economic underdevelopment is not only of particular interest for the Bulgarian regional policy, but is also at the base of realizing a successful strategy for sustainable territorial development of the cross-border region Romania-Bulgaria. Being a key factor in the discourse of regional development, the FDI should be scrutinized in a view to uncover the main regularities and trends in these provinces, as well as potentials and perspectives ahead of the separate administrative units. The analysis of some key indicators connected with the dynamics and distribution of the FDI stocks and their per capita ratio, with the FDI density, and with the proportion FDI-GDP, demonstrates the lack of a distinct and typical for all Danube provinces of Bulgaria trend in the investment activity. However, we find out a common feature in their spatial localization models – the predominant concentration of FDI in the regional centres. The study also discloses the correlations between sectoral structure and FDI supplies, as well as the FDI's role for the changes in some key economic, social, and demographic indicators' values in these provinces. The quantitative analysis' results are complemented with qualitative characteristics of the processes as we put special emphasis on factors such as: the insufficient capacity for creating agglomeration effects; the lack of clusterization based on joint initiatives of the provinces; the relatively weak impact of the free trade zones and the industrial zones; the poor connectivity with the national transport system. The elaborated systematic territorial study of the foreign investments' spatial models in the Danube provinces of Bulgaria is a solid base for designing/implementing a differentiated, adequate, flexible, and proactive regional and local policies.

Keywords: *foreign direct investments, localization models, Danube regions, regional development, Bulgaria*

Rezumat. Analiza comparativă a modelelor de localizare spațială ale investițiilor străine directe în provinciile dunărene din Bulgaria

Provinciile dunărene din Bulgaria se numără printre cele mai puțin dezvoltate regiuni NUTS3 din țară și din UE. Din acest punct de vedere, depășirea subdezvoltării lor socio-economice nu reprezintă numai un interes deosebit pentru politica regională din Bulgaria, dar stă, de asemenea, la baza realizării unei strategii de succes pentru dezvoltarea teritorială durabilă a regiunii transfrontaliere România-Bulgaria. Fiind un factor cheie în discursul dezvoltării regionale, investițiile străine directe ar trebui controlate în scopul de a descoperi principalele legități și tendințe din aceste provincii, precum și potențialul și perspectivele viitoarea ale acestor unități administrative, privite separat. Analiza unor indicatori cheie legați de dinamica și distribuția stocurilor de ISD și a raportului acestora pe cap de locuitor, cu densitatea ISD, și cu proporția ISD-PIB, demonstrează lipsa unei tendințe distincte și tipice pentru toate provinciile dunărene din Bulgaria în activitatea de investiții. Cu toate acestea, descoperim o trăsătură comună în modelele lor de localizare spațială - concentrația predominantă a ISD în centrele regionale. Studiul a prezentat, de asemenea, corelațiile dintre structura sectorială și livrările de ISD, precum și rolul ISD pentru modificările valorilor unor indicatori economici, sociali și demografici cheie din aceste provincii. Rezultatele analizei cantitative sunt completate de caracteristici calitative ale proceselor deoarece s-a pus un accent deosebit pe factorii următori: capacitatea insuficientă pentru a crea efecte de aglomerație; lipsa de clusterizare pe baza inițiativelor comune ale provinciilor; impactul relativ slab al zonelor comerciale libere și zonelor industriale; conectivitate slabă cu sistemul național de transport. Studiul teritorial sistematic elaborat al modelelor spațiale ale investițiilor străine în provinciile dunărene din Bulgaria este o bază solidă pentru proiectarea/ implementarea politicilor regionale și locale diferențiate, adecvate, flexibile și proactive.

Cuvinte-cheie: *investiții directe străine, modele de localizare, regiunile Dunării, dezvoltare regională, Bulgaria*

Introduction

The foreign direct investments (FDI), perceived as a system of interconnected macro-, meso-, and microeconomic categories, are capable to change and transform the regional systems, as well as to influence the economic, social, demographic, and even cultural characteristics of the space. The conceptual integral model of the FDI is a multitude of elements that prove to be important factors for growth/recession, dynamics, intension, mobility, innovations, divergence, turbulence, and many other key attributes of the contemporary world.

A complete methodology for measuring the territorial socio-economic efficiency of foreign investment has not been yet developed. In terms of geographical analysis, the territorial effects are of peculiar interest, especially the relationship between FDI and local development, as well as their role in the transformation of the environment (Borensztein et al., 1998; Casi and Resmini, 2012). Scientific researches suggest that FDI's impact depends to a large extent on the interactions of many diverse factors, such as: specifics of investors and industrial sectors, local economic structure and processes, absorption capacities, local cultural characteristics,

etc., thus FDI could have a very controversial role – rather positive or negative.

Benefits are reported primarily in terms of higher budget revenues, deficit reduction, job creation, increase in high-tech industries and their participation in export, etc. (Pavlinek, 2009). The fact that FDI don't create debt for the state makes them attractive and desirable despite some possible negative consequences. The deployment of the foreign investors' activities is usually accompanied with a growth effect in the national and regional competitiveness, as well as with accelerated development of export-oriented economy in some areas. The effects of attracted investments may be direct and indirect – associated with the effect of foreign companies on the development of local businesses, with the influence on specific industries, and with stimulation of local investments. The indirect economic effects by the migration of capitals should not be neglected as they are often associated with the revival of the real estate market, the appearance of new market players, diversification and increase in the levels of wholesale and retail businesses.

The entry of foreign capital may also cause some negative effects, such as pushing domestic companies out of the market and isolation of local companies in the process of supplying, logistics and other operations. There are many cases where foreign investors do not use local physical and human resources. In such situations FDI don't stimulate the regional development as they have "enclave" patterns of functioning that doesn't bring sensible direct or indirect benefits to the locality and its surroundings. Foreign capitals could also increase the dependence of national and regional economies from the world economy and the global network. Also monopolization and closing of the production cycle in some economic activities by foreign investors may induce some tension among local communities. Foreign companies in disadvantaged regions create jobs, but in many cases that does not lead to an increase in income, to adoption of new manufacturing and managerial culture, or to stimulation of the local suppliers. That could intensify the instability of the local economy with the role of the foreign investors limited to isolated and indifferent presence.

The fact that FDI could rather increase sustainability or provoke instability in the systems is an indicator that there should be individual approaches towards different administrative units and that we need to create an actual picture of the regional crises and investment localization in the context of the territorial concentration and diffusion (Dunning and Gugler, 2008). Moreover, researches provide evidences that the FDI are an important

accelerator of economic growth, but serve at the same time as a stimulant for the widening disproportions in and between the regions. Therefore, the migration of foreign capital may intensify the processes and lead to crisis in the spatial relationship between the centre and the periphery. The places where the TNCs (transnational corporations) are positioned could turn into growth poles and change the territorial structure of the society. In urbanization-agglomeration scenario the economic diversity (that can be induced by FDI) is a key factor for regional development and self-organization with synergic effect.

The analysis in this paper is based on the hypothesis that FDI could be crucial for the underdeveloped regions/countries due to the deficit of domestic financial resources and the pressing need for intensive enterprise restructuring and technological innovations. Thus, the inclusion of the peripheral territories in the internationalization of the economic processes through attracting strategic investors is an opportunity to draw these areas out of the economic isolation and to change their economic behaviour stereotypes. Taking all that into consideration, our primary task is to scrutinize FDI's spatial localization models in the Danube provinces of Bulgaria and uncover the specifics of the investment processes in these peripheral parts of the country. In order to do that, we apply a mixture of quantitative and qualitative analyses, also treating the role of the Danube NUTS3 regions within the whole country.

There are several notions/interpretations of the term "Danube regions", thus the diverse national and EU Danube development strategies and programmes list different Bulgarian provinces (NUTS3 regions). That is why the first thing we should do is determining the territorial scope of our research. What we do in this paper is to concentrate on the regions that have direct contact with the Danube, i.e. the Bulgarian Danube-adjacent NUTS3 regions – these are from west to east the following: Vidin, Montana, Vratsa, Pleven, Veliko Tarnovo, Ruse, and Silistra.

Theoretical framework

Though there has been considerable theoretical work on foreign direct investments, there is no agreed model providing the basis for empirical work (Bevan and Estrin, 2000). Notwithstanding, the different theoretical approaches provide us with an opportunity to disguise some of the key FDI determinants that could explain the empirical results, the observed FDI spatial localization models, as well as the different FDI attractiveness of the regions. In order to uncover the channels through which capitals and new technology flow, it is

important to have an understanding of the long-run determinants of the pattern of FDI stocks, both in terms of the characteristics of the home country and industry, as well as those of the host country (Barrell and Pain, 1997).

Vernon's product cycle approach (1979) explains FDI as a firm's reaction to product imitations by rivals, or to a drop in sales because of domestic market saturation. A product innovation, which is in an advanced stage of the product cycle after its successful market introduction and the standardisation of production, could require FDI for two reasons: firstly, domestic markets could be supplied at lower prices by a network of traditional expensive domestic production plants and new foreign production plants with lower production costs. This leads to relatively lower consumer prices by mixed calculation which could increase total sales again. Secondly, there is a chance of increasing exports through foreign sales affiliates which are closer to the local markets.

Dunning's eclectic paradigm explains FDI by a simultaneous occurrence of three necessary conditions for a domestic parent company: 1) Company-specific competitive advantages, e.g. product innovation, management know-how; 2) internalisation advantages, e.g. protection against foreign cooperation partners who might imitate the domestic firm's competitive advantage; 3) location advantages, e.g. lower labour costs, faster working bureaucracy (Dunning, 1991).

Although both these theoretical approaches are primarily designed to explain why firms are encouraged to invest abroad, certain modifications of their concepts could also be helpful in understanding investment flows between different regions within a country or across state boundaries. Taking into account the theoretical framework, Knödler and Albertshauser (2001) state that the location disparities are expected to be smaller within a country than between regions from different countries.

The probability that a foreign firm locates in a particular region depends on how the characteristics of that territorial entity affect profits relative to the characteristics of all the other alternative regions where the given firm could potentially make investments. Those regional characteristics nowadays are even more important given that the process of European integration has reduced the national specificities perceived by multinationals and that regions within Europe compete to attract FDI's more across than within countries (Basile et al., 2008). That is why multinational firms often consider regions across countries as closer substitutes than regions within national boundaries.

Many studies have tried to shed light on the main factors for attracting FDI at local and regional level.

The literature on the location-related determinants of FDI proposes few important factors that are able to condition investors' choice of a location for their production plants. These factors can be conditionally grouped into two broad sets, i.e. demand factors and supply characteristics (Casi and Resmini, 2011).

Local demand conditions usually refer to market size, market access and growth prospects. The size of the local market as well as access to other neighbouring markets is likely to exert a strong influence on FDI location (GDP growth rate is often used in the literature as a proxy for potential local demand). In particular, market access can magnify the impact of local demand in presence of increasing return to scale in production (Davis and Weinstein, 2003). Therefore, it would exert a strong influence on foreign firms producing on a large scale and seeking to export their products to the rest of regions/countries. Despite the rapid integration process that took place, market access is still unequal across EU regions, mainly because of intangible barriers, such as cultural and administrative ones, to intra-EU trade that still maintain fragmented the EU market (Head and Mayer, 2004). Because of these barriers, regions with a good geographical and economic accessibility to the core markets are likely to receive more FDI than other regions. From that point of view, Deichmann (2001) and Shah (2014) unveil the crucial importance of transportation infrastructure in investors' location decision, and therefore in the FDI spatial distribution and dispersion models.

Supply conditions include a wide set of factors, such as: the structure of the local economy; factor costs; resource endowments; skills of labour force; and all the factors affecting the general business environment faced by foreign firms (Casi and Resmini, 2011). One of the key determinants that seem to affect significantly the FDI flows is the regional sectoral structure. The level of agricultural activity in a given region is of particular importance as it could discourage potential investors by signalling a lower level of industrial development and lack of business services. On the other hand, an overwhelming presence of agricultural activity in a province could reflect lack of potential competition and it could therefore attract investors in the manufacturing or services sectors (Deichmann et al., 2003), although empirical evidences suggest that this mechanism rarely works in practice.

The role of factor costs, and in particular labour costs, is highly debated in the scientific literature. At theoretical level, they are likely to be important for FDI location choice as multinational enterprises are generally able to fragment production processes across space and usually choose the best location for each production stage, thus minimizing total production costs. Therefore, it can be expected that

multinational firms turn to low cost locations for activities relatively intensive in labour. This implies the existence of a negative relationship between labour costs and FDI. However, the empirical results are not unanimous. While some researchers define labour costs as key determinants (Bevan and Estrin, 2000; Janicki and Wunnava, 2004), others (Head et al., 1999; Defever, 2006; Guimaraes et al., 2000) find an insignificant or positive relationship between labour costs and FDI. Empirical evidences suggest that FDI usually concentrate in the richest part of the countries, where wages are higher, because there the investor can find a better infrastructure and easier logistical accessibility from abroad (Antonescu, 2015; Dornean and Oanea, 2015). It has been also argued (Schneider and Frey, 1985; Carstensen and Toubal, 2004) that the degree of human capital development has a favourable impact on FDI inflows in terms of ensuring adequate supply of skilled labour. Moreover, skilled labour is also assumed as a condition for high productivity.

Considering the business environment and the investment climate, many studies emphasize on the role of the agglomerations. In his pioneering work, Knickerbocker (1973) identifies agglomeration as an attractive local feature for firms competing in a single industry. Agglomeration provides a means of gathering information on the local environment (Mariotti and Piscitello, 1995), where presence of other investors is interpreted as proof of success in uncertain markets (Lall and Streeten, 1977). Woodward (1992) and Guimaraes et al. (2000) underline the relevance of such clustering for foreign enterprises as an existing concentration of foreign-owned firms demonstrates the location's potential. The primacy of agglomeration variables in location decision-making is further supported by Deichmann et al. (2003), who underline the importance of follow-the-leader and competitive strategies among foreign firms.

Agglomeration effects usually signal high quality of infrastructure, specialization, higher competition and also a business environment conducive for foreign investors. An important type of agglomeration effect relates to the concentration of business and professional services, thus creating agglomeration economies. They consist simply of those positive externalities resulting from the spatial concentration of existing economic activity. Agglomeration economies result from industry-specific localization obtained when firms in the same industry draw on a shared pool of skilled labour and specialized input suppliers, while more general economies are garnered by firms across all industries (Guimaraes et al., 2000).

Studying the factors that encourage and impede FDI flows into Central and Eastern Europe (CEE), Carstensen and Toubal (2004) find out that the

dispersion of FDI could be explained not only by the traditional variables, but also by transition-specific variables, both of which are found to have significant and plausible effects on FDI flows. The strong influence of transition-specific determinants on FDI actually confirms that traditional variables cannot fully explain FDI flows in the CEE countries. For example, both the level of privatization and the method of privatisation as an indicator for the efficiency of the governance have considerable impact on the decision to invest in CEE countries.

Studies of FDI in CEE have put particular stress on indicators of economic and political risk (Bevan and Estrin, 2000; Janicki and Wunnava, 2004). This generally comprises three main elements: macro-economic stability, e.g. growth, inflation, exchange rate risk; institutional stability such as policies towards FDI, tax regimes, the transparency of legal regulations and the scale of corruption; and political stability, ranging from indicators of political freedom to measures of surveillance and revolutions. Deichman's empirical model (2001) also suggests that the investment climate, measured through the risk rating, is one of the most important determinants of investment activity. Thus, uncertainty linked to the legal, political, and economic environment is often an important deterrent of FDI in the CEE countries.

Summarizing the results from different studies, the European Commission (2006) concludes that the location of foreign firms in Europe is guided mostly by firm specific characteristics, and that only a minor part of the location pattern can be explained by observable regional/national factors. However, the study identifies some very systematic and fundamental economic characteristics of the countries and regions in which foreign investors tend to invest. FDI are generally attracted to regions within countries that have:

- Access to a large national market (national market size effect);
- Borders with the home country and/or language in common with home country (proximity and culture effect);
- A high level of business English proficiency (internationalisation effect);
- Low corporate taxes (fiscal incentive effect);
- Many advanced consumers with high purchasing power (national GDP per capita);
- Low unemployment level (proxy for little rigidity on the labour market).

Given the choice of country, the research furthermore shows that FDI are attracted to regions with:

- A large share of other foreign investors (signal effect)
- Good infrastructure and accessibility, especially to home region (access effect)

- A highly educated regional workforce (skill effect)
- A high level of spending on R&D (innovation effect)
- Penetration of information- and communication technologies (ICT effect)
- A large local presence of competitors, clients and suppliers within the firm's industry (agglomeration and clustering effect).

Despite the solid theoretical base and important advances, most of the empirical analyses considering diverse FDI determinants are based primarily on country/region and/or industry data. Therefore, whether theoretical considerations concerning the traditional location advantages and motivations for FDI are valid at sub-national, regional, and local levels is still a rather unexplored question, which deserves further studies. Moreover, analyses of the FDI determinants and the territorial/spatial structure of the foreign capitals in Bulgaria are relatively rare (Panushev, 2002; Grigorova, 2006; Goev, 2010; Mladenova, 2013; Milanov, 2014), with the majority of studies concentrating primarily on the potential growth effects that could be induced by FDI at national level. There is no thorough research dedicated

exclusively to the analysis of the FDI in the Danube provinces of Bulgaria.

Quantitative analysis of some key FDI indicators

The dynamics in the FDI stocks in the period 2007-2014 (Fig. 1) suggests that we can't find out any clear common trend. The aggregate FDI stocks for all the seven Danube provinces rose from 627 to 1,056 million euro, i.e. with 68.6%, but while some regions registered significant growth rates (Montana \approx nearly 200%, and Ruse \approx 125%), other were characterized with very slow progress (Vidin \approx 14.8%, Vratsa \approx 11.4%, Silistra \approx 6.7%). On the other hand, despite all the Danube regions had larger values for this indicator in 2014 in comparison to 2007, only two of them (Ruse and Pleven) managed to increase substantially their nominal FDI stocks. As a result, in 2014 the leader in terms of FDI supply was Ruse (386 mil. euro), followed by Pleven (307 mil. euro), while three of the provinces heavily lagged behind \approx Vidin (51.7 mil. euro), Montana (34.2 mil. euro), and Silistra (31.7 mil. euro).

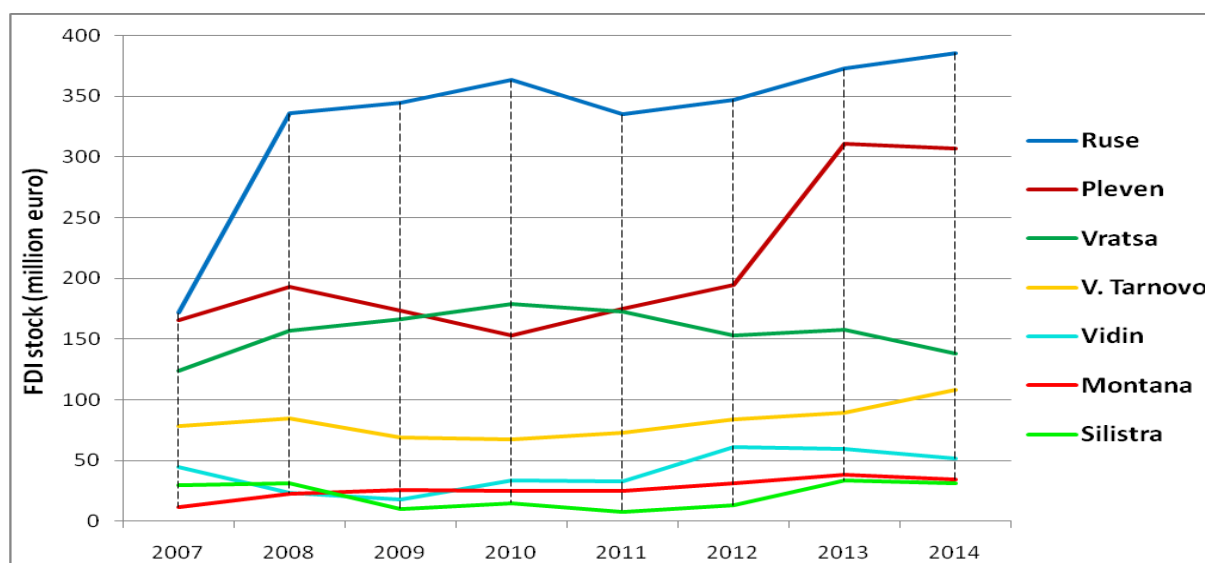


Fig. 1: The dynamics in the FDI stocks (2007-2014)

All that leads us to the logical question: "When all the Danube regions registered growth in FDI stock, did they manage to compensate for their falling behind in comparison to the other Bulgarian regions?". While in 2007 in the seven Danube provinces were concentrated 4.13% of the total FDI stocks in Bulgaria, in 2014 the value for this indicator rose to 4.89%. Notwithstanding the slight increase of the percentage, we can talk by no means about a catch-up process, because if we had

balanced dispersion of investments among all the regions, the seven Danube regions (1/4 of all 28 Bulgarian provinces) should attract 25% of the total FDI stocks (more than 5 times higher than what was in 2014). Moreover, despite initially having very low levels of FDI, four of the seven Danube regions dropped further behind, with the most typical case being Vratsa \approx from 0.8% to 0.6% of the total FDI in Bulgaria (Fig. 2). On the other hand we have also two positive examples \approx Ruse and Pleven, but

despite the positive trends, their FDI stocks remained relatively low for the country.

An indicator, which could help us foresee better the potential impact of the foreign capitals over society, is the FDI stock per capita (Fig. 3). Again, Montana generated the highest growth rate (approximately 250%) in the 2007-2014 period, while Ruse and Pleven registered very high increase in nominal values. What is more interesting here is the general trend suggesting that the more initial FDI per capita a given region had, the more likely to attract new capitals. That is to say that even within the Danube region itself we have no reasons to expect convergence in terms of FDI per capita. The stunning differences between the provinces are illustrated by the fact that in 2014 the FDI per capita in Ruse (1,694 euro) were higher than the total sum for the four least attractive for investors provinces – Vidin (554 euro), Veliko Tarnovo (437 euro), Silistra (276 euro), and Montana (246 euro). Thus we can conclude that foreign capitals could hardly be a substantial factor in the regional economy of those provinces.

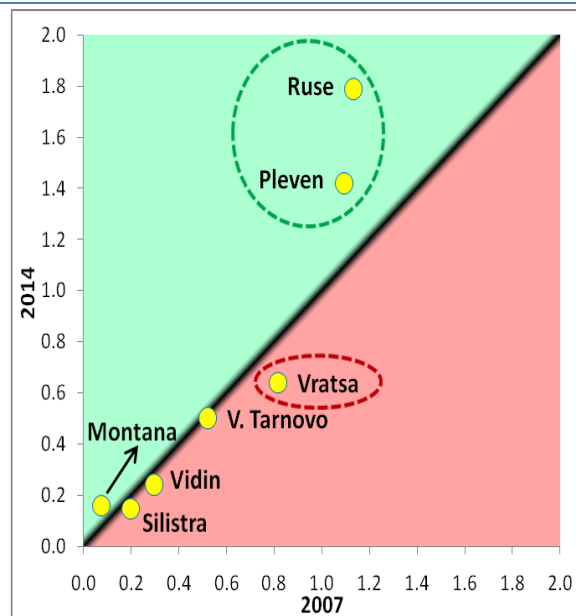


Fig. 2: The FDI stocks as % of total for Bulgaria (2007 and 2014)

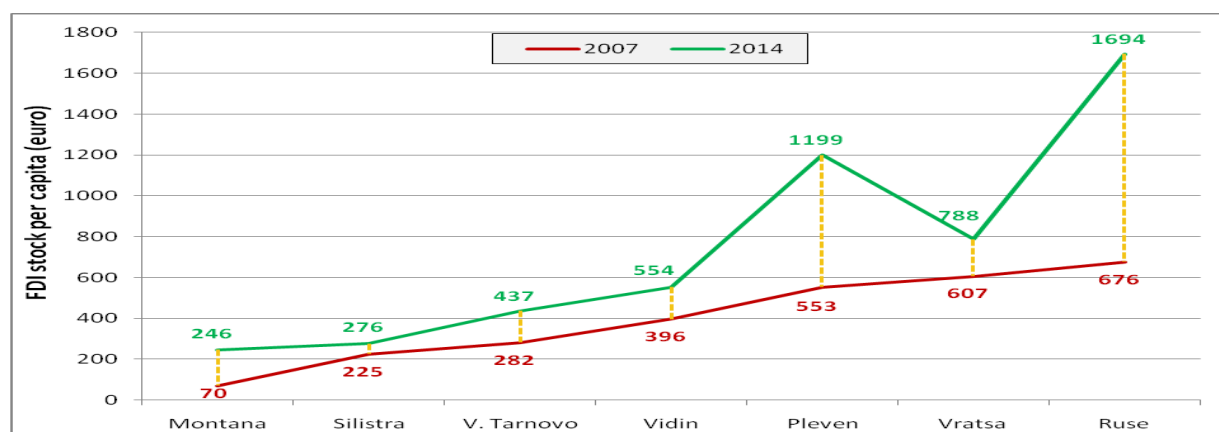


Fig. 3: The FDI stock per capita (2007 and 2014)

To find out how the Danube provinces fit within the FDI spatial localization model at national level, we elaborate classification of all the 28 Bulgarian NUTS3 regions based on FDI per capita (Fig. 4). The seven groups demonstrate clearly the differences between the administrative units, as well as the unfavourable situation in the Danube region. With its 11th place and nearly 1,700 euro FDI per capita, Ruse is the only region that belongs to the average group, while at the same time five of the regions fall into the two bottom groups (with FDI per capita of less than 800 euro). Montana is the Bulgarian province with lowest supply of FDI per capita occupying the last 28th position; Silistra is placed on 26th, and Veliko Tarnovo – 24th.

After uncovering the situation at country level and the very low supply of FDI stock per capita in

the Bulgarian Danube provinces, it would be also interesting to scrutinize the processes at a larger scale, comparing the values to those for the neighbouring and EU countries. As the empirical data at lower territorial levels is scarce and often unreliable for some of the countries, we calculate the results at national level (Table 1). Although the model (Fig. 5) is far from being clear and straightforward, the general trends suggest that we observe relative decline of FDI stock per capita in both North – South and West – East directions, with South-eastern European countries characterized with the lowest levels of FDI supply. Despite Bulgaria has higher FDI stock per capita than all of its neighbouring countries and is also on the 23th position among the 31 states included in the research, the value for the Bulgarian Danube regions

is lower even than that for the country with the most unfavourable FDI supply per capita – Turkey.

Another indicator that illustrates eloquently the very low supply with investments in the Danube region is FDI density (here it was calculated on euro per 100 sq. km.). While the average for Bulgaria is close to 2,000 euro (Table 2), besides Ruse, all the other Danube regions are very far from that value.

The reason for that lies to a large extent in the huge concentration of FDI in Sofia (that raises substantially the average FDI density), however, even if we compare the Danube-adjacent regions to the other Bulgarian provinces (excluding Sofia), the results again are not very positive with Silistra and Montana having the lowest FDI density among all the provinces.

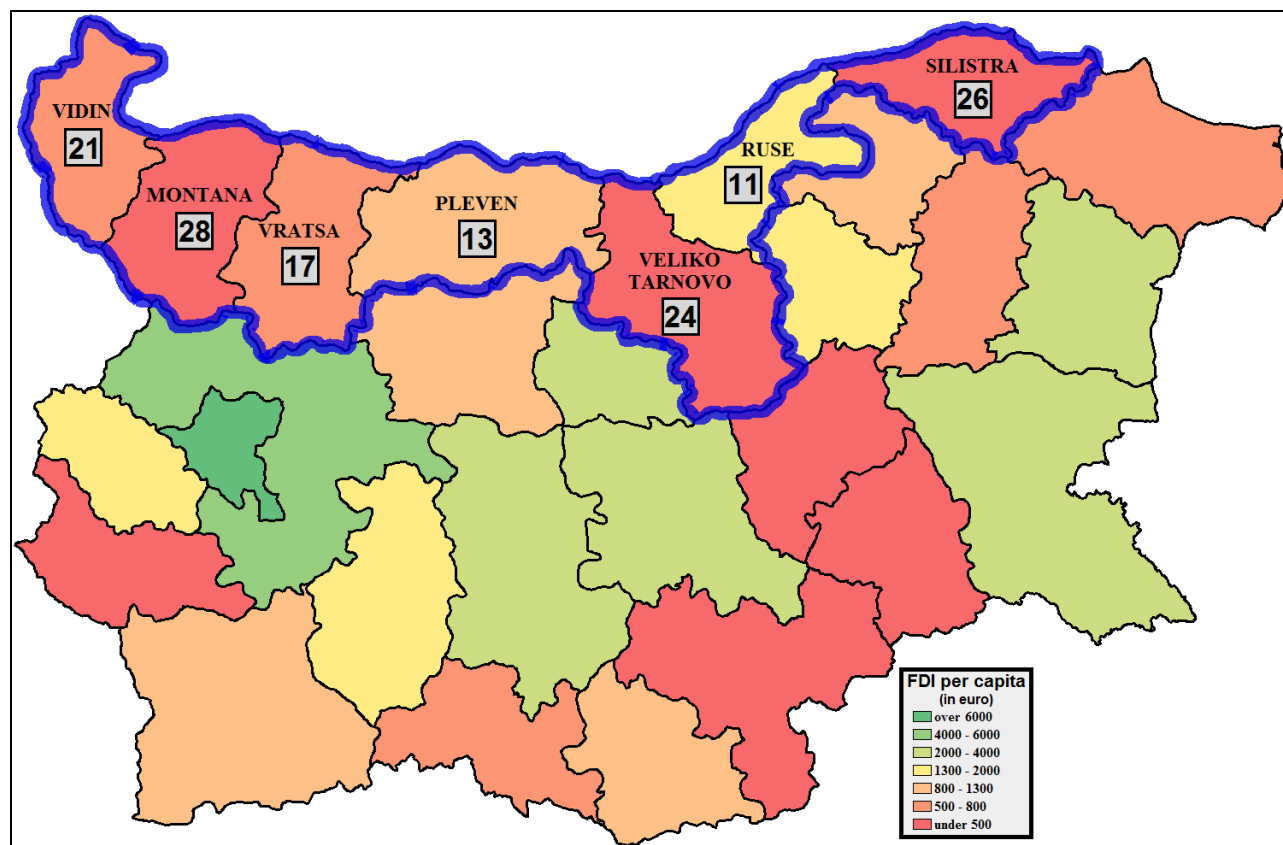


Fig. 4: The FDI stock per capita and position among all the 28 Bulgarian provinces (2014)

Table 1: The FDI stock per capita in the EU and Bulgaria neighbouring countries (in US dollars for 2013)

country	FDI/c.	country	FDI/c.	country	FDI/c.	country	FDI/c.
Luxembourg	266565	Cyprus	24420	Hungary	11152	Poland	6595
Belgium	83211	Austria	21607	Slovakia	10794	Lithuania	5651
Ireland	81625	Finland	18670	Germany	10293	Romania	3899
Netherlands	39985	Estonia	16664	Latvia	7635	Serbia	3480
Sweden	39505	France	16252	Croatia	7572	Macedonia	2626
Malta	34637	Spain	15258	Slovenia	7353	Greece	2493
Denmark	28296	Czech Rep.	12705	Bulgaria	7285	Turkey	1941
United Kingd.	25330	Portugal	12112	Italy	6620	Danube prov. (BG)	1889

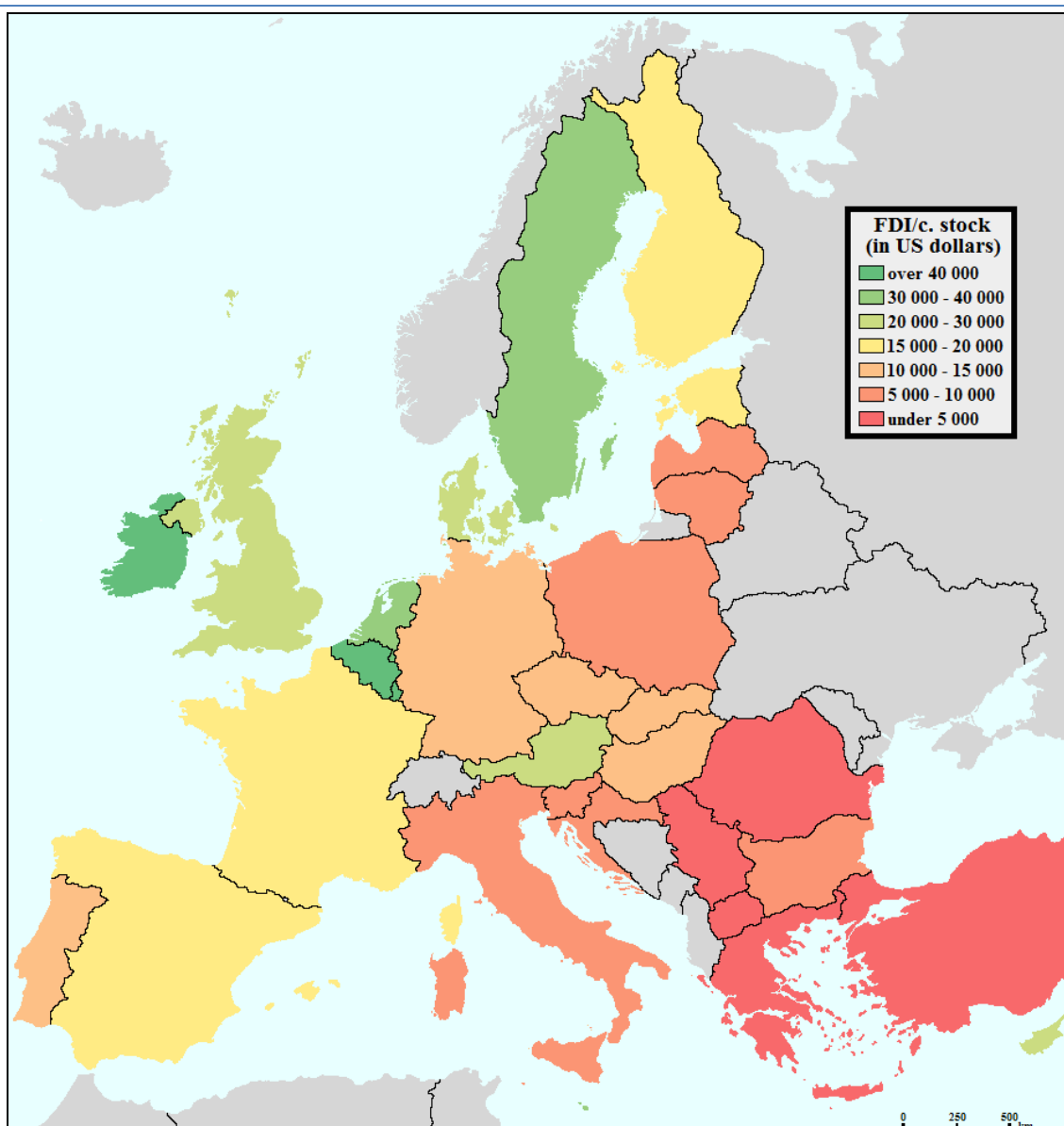


Fig. 5: The spatial dispersion of FDI in the EU and Bulgaria neighbouring countries (stock per capita for 2013)

Table 2: The FDI density (2014)

NUTS3 region	Euro per 100 sq. km.	Position (out of 28 NUTS3)
Ruse	1376.2	6
Pleven	707.3	12
Vratsa	381.4	16
Veliko Tarnovo	232.0	22
Vidin	170.4	24
Silistra	111.3	27
Montana	94.1	28
Average for Bulgaria	1948.3	

After describing the unfavourable situation in the Danube regions considering FDI, we try to explain empirically one of the major reasons (further explanations follow in the next section dedicated to qualitative analyses) by providing quantitative arguments proving the relation between the sectoral structure and the foreign capitals. In order to find out first eventual trends at national level, we make comparison between the index of sectoral localization and FDI stock per capita including all the 28 Bulgarian NUTS3 regions (Fig. 6). The trend line and the correlation coefficient (-0.59) demonstrate that generally the higher the index of localization in agriculture is, the lower are the FDI per capita in a region. On the other hand, the higher the index of localization in services is, the higher the FDI per capita are (the Pearson correlation coefficient equals to 0.82). We have also positive correlation between

the industrial sector and the FDI per capita, but the coefficient is lower (0.47). Analysing the index of localization results for the Danube provinces, we reveal that the sectoral structure could definitely be considered as a major factor for the low FDI stock in the region (Table 3). All the Danube regions have the highest values in the agricultural sector and very low ratings for industry, and especially for services. The three regions with the most unfavourable sectoral structures (Silistra, Montana, and Vidin) are

also some of the provinces with lowest supply of FDI per capita. The opposite case is Ruse – a more balanced sectoral structure and the highest FDI stock per capita. However, a comparison between Veliko Tarnovo and Pleven suggests that the correlations between the index of localization and the FDI supply might not always be so straightforward.

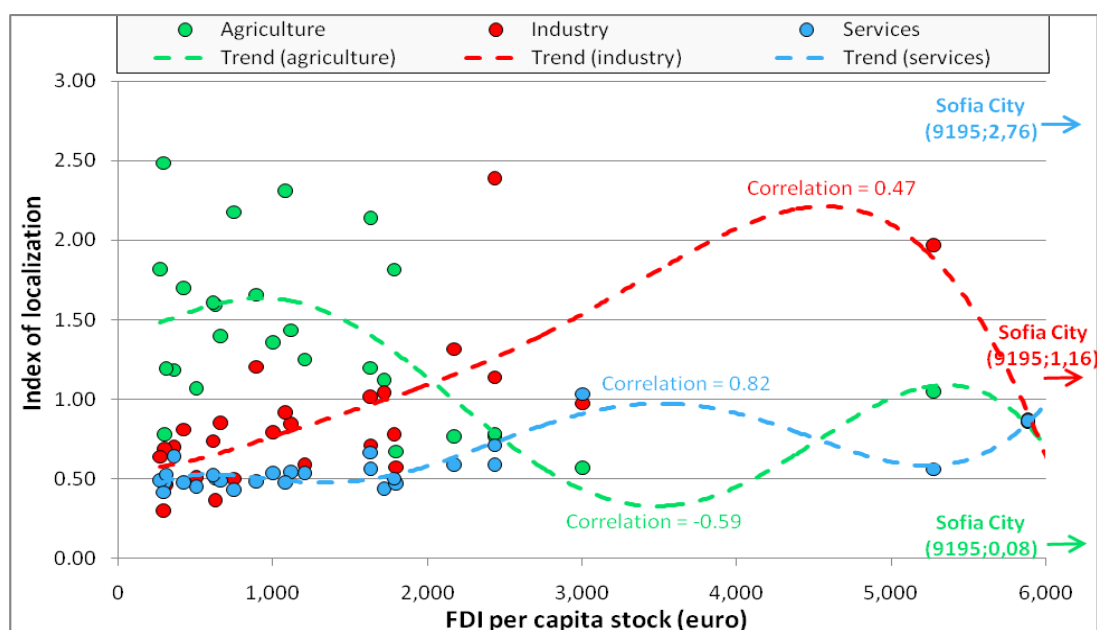


Fig. 6: The FDI and Index of localization (2013)

Table 3: The index of localization for the Danube provinces (2013)

	Index of localization		
	Agriculture	Industry	Services
Veliko Tarnovo	1.18	0.70	0.64
Vidin	1.60	0.37	0.50
Vratsa	1.66	1.20	0.48
Montana	1.82	0.64	0.49
Pleven	1.25	0.59	0.54
Ruse	1.20	1.02	0.66
Silistra	2.48	0.30	0.42

To find out how the FDI supply can influence the overall development of the Danube region, we compare the dynamics in the foreign capitals per capita with that in two key socio-economic indicators – GDP per capita and income per capita (again for the period 2007-2014). The trend line (Fig. 7) provides evidences that we have a very strong

positive correlation between the three indicators, which is also attested by the very high (close to 1) Pearson correlation coefficients. That gives us a hint that FDI might really be an important tool in fostering the development of the Danube region, although, of course, such a statement might be considered too generalized without further and more detailed researches.

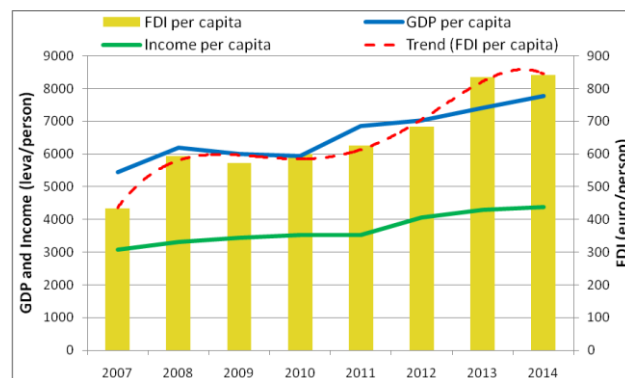


Fig. 7: The FDI, GDP, and Income in the Danube provinces

Qualitative analysis of the FDI related processes within the Danube provinces

In the previous chapter we presented and analysed different quantitative dimensions of the FDI spatial characteristics in Bulgaria providing also an overview over the dynamics of the processes within the seven Danube-adjacent provinces. However, even the large amount of deduced quantitative/numerical connections and correlations between the socio-economic processes and the dispersion of capital stocks among the regions can't uncover the reasons for the low investment activity, the qualitative aspects of the investment processes, as well as the spatial behaviour of concrete foreign firms and their role in the regional scenarios. In order to study in more details these crucial aspects we first describe and compare the processes in two of the typical Danube provinces (meaning that their administrative centres are situated at the banks of the Danube River) – Vidin and Ruse. That choice makes a good case-study despite having some common characteristics, those regions are characterized, as described above, with significant difference in terms of FDI supply. Then we summarize the most important issues that are common for all (or almost all) the provinces and set the development pattern in the whole Danube region.

The province of Vidin, which is at the bottom of the classification in terms of FDI stocks for more than 15 years, is a typical example for a region with very strong inertness of the socio-economic processes. Notwithstanding that the province is at the entrance/exit axis of the Pan-European transport corridor №4 (even more important for Vidin after the inauguration of the Danube Bridge "New Europe", a.k.a. Danube Bridge 2) and has on its territory well developed harbour infrastructure and a free trade zone, the investors' interest remains insignificant. Some of the major stumbling blocks ahead of attracting FDI are: the large number of key for the regional economic structure manufactories that don't function; the ageing population and the critical demographic situation; the low-skilled workforce; the absence of economic clusters; the lack of a higher education institution. Although the province of Vidin has already secured a good transport connection with Romania, the foreign capitals originating from that country are very low. This trend is however typical not only for Vidin, but also for the other Danube regions of Bulgaria despite the support and their active participation in the EU Strategy for the Danube Region.

The leader among the Danube provinces – Ruse has most of its FDI in the spheres of industry, trade, and construction. For a long period over 2/3 of the foreign capitals are concentrated in the processing

industry, while over 100 economic enterprises are occupied in the production of machinery and equipment – a fact that distinguishes the region from the other studied Danube-adjacent territorial units. The rise of the FDI stock in the province after 2007 is primarily connected with the functioning of the industrial zone "Ruse" where among the first major investors was the French company for automobile parts manufacturing "Montupet", followed by the Spanish "Keros" specialized in manufacturing wall and floor ceramics, "MBM-Metalwork" and "Balkanzinc" – both metallurgical plants, as well as one more factory for automobile parts – the German "WITTE Automotive". All these enterprises are built as greenfield investments – a trend that is not typical for the other Danube provinces. Our study reveals that some of the key motives for the investors to choose this location were connected with: the proximity to a harbour and also to the transport corridors №7 and №9; workforce with experience in some industries; the functioning of a decent technical infrastructure; gasification; own electrical sub-station; a university with technical subjects/profiles. The University of Ruse could definitely be considered as a factor for regional and local development and the impact of the higher education is another landmark feature of this province. There are many examples that illustrate the good cooperation between the technical university and some business enterprises, thus stimulating synergetic effects (generally missing in the provinces of Vidin, Montana, Vratsa, Pleven and Silistra). The newly built production capacities change the industrial profile of Ruse and foster the attraction of other foreign companies as a result of the growing potential for agglomeration-localization effects. In the region are also registered Romanian investments – mainly in the fuel trading and the production of paints and varnishes. However, the investments originating from Austria are relatively low (especially given that Austria is one of the main investors in Bulgaria), which is surprising considering the historic and geographical connections through the Danube. In Ruse there are situated as well some big German and Israeli tailoring companies, some of which have realized full-cycle production of confection and have created a network of local subcontractors in some smaller cities and villages. In this way the foreign capitals fit well in the economic system and turn into a factor for local development. Unfortunately in all the other Danube provinces the FDI are most often characterized with "enclave" or "indifferent" spatial behaviour (with only a few exceptions, such as "Holcim" in the region of Vratsa). In contrast to the other studied administrative units, there is a trend of raising interest from IT firms in the region; however

it is limited to a certain extent by the remoteness from the capital and the low transport connectivity of Ruse with the inner parts of the country.

Regardless of the declared priorities and objectives in their regional and local policies, the Danube provinces attracted very low amount of investments in the past 15 years, which is an indicator of inertia processes. Despite that many municipalities were exempted from paying the corporation taxes and had a good infrastructure, the foreign investments remained insignificant. The built enterprises through greenfield investments are few, while the foreign participation in the big factories is weak. The FDI supply in the peripheral territories is very low because of the lack/deficit of human resources, of sound production and infrastructure base, and on account of the economic, cultural, and social degradation processes. Since 1989 the Danube provinces registered the most acute demographic crisis in the country, the highest levels of unemployment, negative trends in the educational structure, and the most serious failures of regional economies. As a result there aren't any large basic industries while also some high-profile companies from the recent past have suspended their activity. The benefits from the presence of foreign investors, such as technology transfer, higher incomes, and others, are not felt in these regions due to the dominance of economic activities with low added value.

In most of the Danube provinces the foreign investors' interest in reaching privatization deals was weak. Later the investment climate was further compromised by the processes of growing deindustrialization. After the privatization, some emblematic productions ceased to function: the chemical factory "Himko" (Vratsa), the production of synthetic fibres in Vidin, of fibreboard in Silistra, as well as the cement and the petroleum refining industries in Pleven. There are no big strategic investors or TNCs proving once again the unpopularity of the Danube provinces as an investment destination. Even the international logistics and transport companies are not that much given the suitable conditions for their localization in the region. This is partially because the majority of the studied regions are characterized with weak connectivity to the national transport system. On the other hand the low level of connectivity among cities and villages in the Danube region itself is a major obstacle ahead of realizing common initiatives. In short, the outlet on the Danube River, the availability of harbour infrastructures and ferries, the international road networks crossing the regions, the common border with a member-country of the EU – all that positive factors can't compensate for the negatives caused by the demographic crises, the

economic collapse, and the bad condition of the roads.

Another typical feature for almost all of the Danube provinces is the insufficient capacity to foster agglomeration-localization model of attracting FDI that could stimulate synergetic effects in the economic systems. In this context, the deficit of large agglomerations in some regions is an obstacle to attracting major investors, because there are not enough strong centres that can comprehensively organize and modernize the territory as an investment location. That is one of the reasons for the weak investment activity not only in the north-western, but also in the peripheral southern and western border regions of Bulgaria. Both theory and global practices suggest unambiguously that the capital migration is oriented primarily towards central places and agglomerations. Moreover, foreign investors have a marked interest in well-functioning clusters, industrial zones, free trade zones, incubators, and other modern forms of spatial organization. In the Danube provinces, however, there are no significant processes of clusterization, while the formed industrial zones are not very attractive for the investors (with the exception of the one in Ruse). According to the Bulgarian Investment Agency major investors refuse to invest financial resources in Bulgaria exactly because of the absence of well-functioning industrial zones and that's why they are moving to Poland, Hungary, and the Czech Republic. On the other hand the two oldest free trade zones also don't provide the needed stimulus for attracting FDI in export-oriented industries, although that was one of the major reasons for their creation.

The Danube regions are characterized with relatively low share of the tertiary sector (services) and higher importance (than the average for Bulgaria) of the agricultural sector. Notwithstanding the considerable relative weight of agriculture in the sectoral structure, it doesn't attract a large amount of foreign capitals. The Bulgarian Danube provinces are in a state of fierce competition with the Romanian Danube regions and at this stage they are losing the "battle", which is clearly attested not only by the preferences of the new investors, but also in the relocation of some production, warehouse, and logistics activities from Bulgaria to our northern neighbours. The Bulgarian provincial and municipal structures don't use adequately the opportunities for joint-actions in creating regional clusters, common marketing and image packages, and other instruments for territorial PR.

The discussed specifics of the investment process in the Danube provinces makes us conclude that the outlet to one of the most important European rivers remains underutilized. Although characterized with many similar features, the Danube provinces take to

a different extent advantage of their potentials considering geographical/spatial positioning and opportunities for cross-border cooperation. That is why we can't talk about a common Danube investment model.

Models of FDI's spatial localization within a region

On the base of the quantitative and qualitative analyses conducted in the previous chapters and after further in-depth study of the foreign capitals' localization patterns within the provinces, we define 5 different types of spatial investment models at

regional level: metropolitan; gravitating to the capital city; centripetal; centrifugal (Fig. 8). This classification of the models is to a certain extent conditional, as on one hand they are constructed taking into consideration also some qualitative characteristics, and on the other some of the provinces have features suggesting that they could fit into more than one model. Again what we first do it is describing the thorough picture within Bulgaria, so we can later compare the Danube provinces not only between them, but also to the others, and explain the specifics of the processes there.

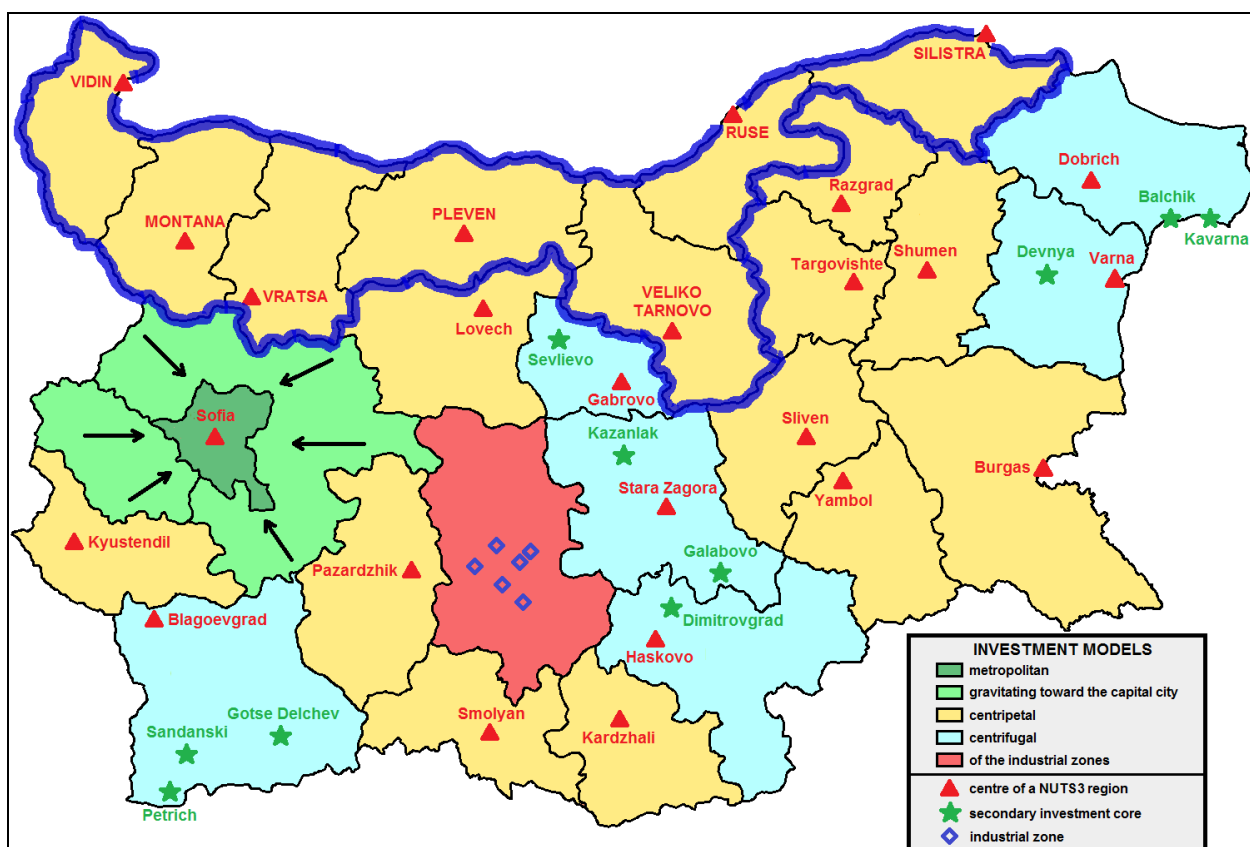


Fig. 8: The spatial localization investment models (2014)

Undoubtedly, the leader in attracting capitals is Sofia city has a unique investment model. In the metropolitan model, the urban-agglomeration effect of the FDI is distinguished most vividly. At the same time the model of Sofia province (the only one without administrative centre) is based on an investment behaviour subordinated to the proximity of the capital city, so it can be defined as gravitating to the capital investment model. Due to the strong agglomeration processes and the territorial proximity between Sofia and Pernik, this model might also include the province of Pernik, although in comparison to the Sofia region it has significantly lower values in almost all FDI indicators and the

localization behaviour of the investors is not motivated only by the proximity to the capital.

Another investment model that can be highlighted is linked with Plovdiv region where the investment flow is directed mainly towards the industrial areas that form "Trakia economic zone" – the only formation of its kind in the country. The tendency for strengthening of the capital flows towards industrial zones is possible to change the investment patterns in some administrative-territorial units (if these spatial forms of organization are effective and realize the opportunities to attract investors). Such a potential exists in the provinces of Ruse, Sofia, Burgas, Shumen, Plevan, etc. giving us

reasons to believe that this model could spread more in the future.

The centrifugal investment model is characterized with significant presence of large investors outside the administrative centre, therefore with the existence of at least two investment cores. Provinces that could be assigned to this group are: Blagoevgrad, where there is a high concentration of foreign capital in the southern periphery and relatively balanced spatial distribution of foreign investments; Stara Zagora, with the largest investments in Galabovo Municipality connected with the energy complex Maritsa-East; Gabrovo, with significant FDI concentrated in the municipality of Sevlievo, which attracts daily work trips from three neighbouring regional centres and surrounding villages; Varna, with industrial specialization of the investment flow in Devnya (unlike the administrative centre where investments are attracted primarily in the tertiary sector); Dobrich, with strong investment interest in Kavarna Municipality in the past few years; Haskovo, with outstanding competitive investment advantages of Dimitrovgrad Municipality. As a result of the FDI flow, we register clusterization stimulating certain synergetic effects in the provinces of Gabrovo, Stara Zagora, and Varna.

Finally, most of the regions (17 out of the 28 Bulgarian NUTS3) are characterized with the so called centripetal model – meaning that we have an investment core formed in the administrative centre of a province where the majority of the regional FDI are concentrated, while at the same time no significant secondary investment core could be registered. The results from the conducted analysis in this paper provide solid ground to assign all the Danube provinces to this centripetal localization model. The peripheries of those regions could easily be classified as marginalized areas bearing typical negative characteristics for such zones: weak economic activity; spatial isolation from the main FDI flows; inertness of the socio-economic processes; lack of the needed human and capital resources to change the status-quo and convert the negative trends.

Conclusion

The analysis of some key FDI indicators demonstrates lack of a distinct and typical trend for all the Danube provinces of Bulgaria in the investments activity, with significant differences in terms of FDI stocks among the studied regions. However, we find out a common feature in their spatial localization models – the predominant concentration of the FDI in the regional administrative centres. The study also discloses the significant correlations between sectoral structure and FDI attraction, as well as foreign capitals'

interconnection with the changes in some key economic and social indicators in these provinces.

Our quantitative analysis' results are complemented with qualitative characteristics of the processes as we put special emphasis on some crucial factors, such as: the insufficient capacity for creating agglomeration effects; the lack of clusterization based on joint initiatives of the provinces; the relatively weak impact of the free trade zones and the industrial zones; the poor connectivity with the national transport system; the demographic collapse. The study provides irrefutable arguments for the presence of self-reinforcing negative factors and inertness of the processes. That is why the majority of the Danube provinces are characterized with unutilized capacities for attracting FDI and unused potentials for cross-border cooperation.

The elaborated systematic territorial study of the FDI spatial localization models in the Danube provinces of Bulgaria could become a solid base for designing/implementing innovative, differentiated, adequate, flexible, and proactive investment policies and PR initiatives. Such studies are essential also in terms of constructing a policy that takes into consideration the local conditions and the globalization of the economic systems. Our survey suggests that the development of less favoured territories requires stronger links with the centre, proactive local policy for attracting not all foreign investors, but, selectively, those that would be easily incorporated in the local surroundings and would drive the progressive changes. Regions compete for foreign investment and that is why they need to position their unique advantages embodied in planning documents for development, advertising campaigns, and other means of territorial marketing. Applied at regional and local level the innovative political approaches could turn into the needed lever to foster development and find out adequate responses to some of the long-standing problems.

Author contribution

Hristo Dokov was primary responsible for conducting the quantitative analyses, while Kalina Milkova was in charge of scrutinizing the qualitative aspects considering FDI processes. Both authors contributed in the design of FDI's spatial localization models, as well as in summarizing the final results and conclusions.

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Geodiversity and geoheritage in Geography teaching for the purpose of improving students' competencies in education for sustainable development

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Abstract

Sustainable development has become one of the burning issues on a global, local and individual levels as a result of climate changes, pollution, rapid development and changes in the global information, economic, industrial and business sectors and value systems. In this sense, education for sustainable development, as part of lifelong learning, has become one of the most important strategic and educational policy issues in Serbia. The aim of this paper is to highlight the potential of geography as a school subject, with special reference to the role of the subject matter of geoheritage and geodiversity in education for sustainable development. The aim of pointing the benefits of integrated and out-of-classroom approaches in teaching geography, which favour an active, experiential and exploratory approach to learning about geodiversity and geoheritage, is that students can acquire competencies in sustainable development. As outcomes of geography classes, competencies also represent a basis for raising awareness and increasing accountability and responsibility in individuals for preserving geoheritage and geodiversity as part of the Serbian national treasure.

Keywords: *geodiversity, geoheritage, Geography teaching, student competencies, sustainable development*

Rezumat. Geodiversitatea și patrimoniul în predarea geografiei cu scopul îmbunătățirii competențelor studenților în educația pentru dezvoltare durabilă

Dezvoltarea durabilă a devenit una din problemele care cere soluții imediate la nivel global, local și individual, ca urmare a schimbărilor climatice, poluării, dezvoltării rapide a societății, dar și a transformărilor survenite în schimbul de informații, sectorul economic, industrial și de afaceri și a amprentei asupra sistemului de valori. În acest sens, educația pentru dezvoltare durabilă, ca parte a învățării pe tot parcursul vieții, a devenit una dintre cele mai importante politici strategice și de educație în Serbia. Scopul lucrării este să sublinieze potențialul geografiei ca disciplină de studiu, cu referire specială asupra rolului patrimoniului și a geodiversității în educația pentru dezvoltare durabilă. Beneficiul abordărilor integrate și în afara sălii de curs în predarea geografiei, favorizând o perspectivă activă, experiențială și exploratorie în învățarea despre geodiversitate și patrimoniu este acela al creării competențelor pentru dezvoltare durabilă. Ca rezultate concrete în învățarea geografiei, competențele reprezintă și fundamentul conștientizării și creșterea responsabilității individuale în conservarea patrimoniului și a geodiversității ca parte a tezaurului național sârb.

Cuvinte-cheie: *geodiversitate, patrimoniul, predarea geografiei, competențe, dezvoltare durabilă*

Introduction

In recent decades, the issue of sustainability has gained importance and topicality as the result of both global and local environmental, social and economic issues and events. In order to introduce adequate measures and be able to respond to newly arisen circumstances, education for sustainable development has become an important element of social development and a common future which puts orientation towards the concept of sustainable development in the foreground.

In 2008, Serbia adopted the National Strategy for Sustainable Development with the aim of getting closer to the practices of developed countries. The Strategy defines sustainable development as "a target-oriented, long-term (continuous), comprehensive and synergetic process that influences all aspects of life (economic, social, environmental and institutional) at all levels" (National Strategy, 2008). The concept of sustainability has gone through several phases in its

development. The dimensions of sustainable development and the principles of sustainability were defined at the World Summit in Johannesburg (2002). "The central and specific characteristic of sustainable development as a paradigm of public policy debate is shifting the focus of debate from the traditional environmental protection to the concept of sustainability, which requires a much more complex process of exchange of social, economic and environmental priorities" (Carter, 2001). This concept includes both dynamic and active aspects of sustainability. "Sustainable development is a process and not a state or an objective that has (not) been achieved" (Husanovic&Pejnovic, 2011).

In this sense, a holistic, multi-perspective approach to understanding the components of sustainability and the dynamic character of the approach provide a basis for implementing the concept of sustainability in educational systems (Andjelkovic, 2015). The process of education for sustainable development has thus become increasingly important from qualitative and

quantitative aspects, but its concept, viewed as a starting point and a goal of education, cannot make any progress or develop without educated and competent individuals. In what concerns the current changes in relation to the concept of sustainability as well as consequences in education caused by these changes, it is necessary to establish partnership with the community. It is expected of school to be more open towards the community and foster de-contextualization of knowledge, which implies a larger share of out-of-classroom learning in the process of achieving the content of the school curriculum. In this sense, the insistence on presenting as much geography content as possible, especially content from geodiversity and geoheritage in the field, is a good step forward in formulating the conception, but also the methodical and didactic shaping of the teaching and learning process in geography classes based on the concept of sustainability. This approach creates potentials for greater use of natural and social resources of the environment so that students can acquire competencies for sustainable development.

Changes in educational outcomes- students' competencies based on concept of education for sustainable development

The prospect of achieving sustainable development in the Republic of Serbia lies in introducing, adapting and applying the principles that dominate the European Union, i.e. in increasing the competitiveness based on knowledge, innovation and entrepreneurship, as defined in the Lisbon Strategy. In that respect, sustainable development becomes a guideline and framework for making changes in many segments of society, directly effecting changes in the field of education (goals, outcomes, teaching strategies, students' competencies). The objectives of education for sustainable development include: development of critical thinking, respect for others and those who are different, responsible local and global actions, understanding the complexity of the problem, an ability to predict future events, responsible behaviour, understanding of complex interdisciplinary relations, ability to identify and clarify environmental values (DESD, 2009). "The setting of conceptual framework starts in school, to include knowledge, skills, new perspectives and rebuilding and reorientation of the existing education into a new form. A concentric orbit of implementation of education for sustainable development and inclusion in its conceptual framework can be seen from school to the local

community and other social systems" (Hopkins& McKeown, 2002, quoted according to Andjic, 2012).

Such an approach puts education for sustainable development in the wider context of socio-cultural, political factors, culture and quality of life on both global and local scales. In such context, the term "education for sustainable development" does not only entail the implementation of programs on sustainable development in the education system, but also a (new) system of education that supports knowledge-based economy and represents a necessary precondition for sustainable development of economy and society as a whole. To achieve this, education for sustainable development must ensure the integration of knowledge from all relevant sectors (environmental, economic, social), with special emphasis on application of such knowledge with the aim of fostering competent individuals who can respond to the challenges of modern-day society.

In that respect, new tasks are set before education, such as strengthening the corpus of procedural, applied knowledge as an important element of adapting to the labour market, ensuring access to quality education for all, strengthening early childhood education and developing a system of continuing education for environmental protection, as well as broadening the range of abilities of educated people in accordance with the changes in technology and the economic environment. It should integrate the concept of interdisciplinary education for sustainable development and greater participation of civil society. This means that it must ensure the participation and mutual cooperation of all stakeholders (schools, businesses, decision makers, civil society) and intensify international cooperation with the relevant scientific-educational institutions (Ministry of Education, International Management Group, 2010).

Educating people on how to identify current problems of sustainability on local and global levels, assess such problems and actively participate in the processes of developing and designing the present and the future are the objectives contained in the documents and declarations of the United Nations. Education, both formal and non-formal, plays a crucial role in the realization of these objectives. It involves the acquisition of procedural knowledge, values and attitudes, but also willingness to participate and act in accordance with one's own principles. Education understood from this perspective requires changes in the manner of teaching and learning as well as in the outcomes of teaching based on competencies. "A knowledge society and a knowledge-based economy do not imply rigid, factual, school-like and textbook knowledge, but a set of skills, abilities and interests (competencies) to create innovation, solve problems, cooperate with others and work for the common good. In this regard, it is important to take

into account various types of knowledge, which respond not only to the questions of "what" and "when", but also "why" and "how" (ibid, 2010).

The concept of education for sustainable development is becoming a framework for formulating new learning outcomes and students' competencies based on those outcomes. In this sense, the goal of the educational process is for students to acquire competencies (knowledge, skills, and attitudes) to assess, compare, manage risks, link concepts, ideas and results, test evidence and propose creative solutions to improve sustainability. In 2006, the European Parliament and the Council of the EU gave recommendations to its member states on how to support the development of key competencies within the framework of their strategies for lifelong learning and sustainable development. In this context, a competency "means the internal capacity of a person that is expressed in the performance of relatively complex activities, while its basic structure is based on knowledge, skills, attitudes, values and reflection conditioned by the demands of the context in which each competency is demonstrated" (Ministry of Education, International Management Group, 2010: 13). Although current legislation does set a basis for the competence-based approach and related measures aimed at improving the quality of education at all levels, there are still many problems with implementing this concept in the teaching practice. This is primarily due to the prevalence of lecture-based methods, too extensive curricula and syllabi and a lack of interdisciplinary linkage of topics and subject matter. As a result of such a teaching paradigm, students acquire mainly theoretical, reproductive knowledge. In keeping with the precepts of sustainability, the goal of the paper is to stress the importance of geography as a school subject and place special emphasis on content related to geodiversity and geoheritage, which can be implemented together with the constructivist and contextual approaches to teaching with the aim of acquiring procedural and functional knowledge.

Changes in learning and teaching process brought about by embracing the concept of sustainability in teaching Geography

As a subject taught in school, geography has a significant potential for improving and implementing the concept of sustainable development. Education for sustainable development requires a multidisciplinary and interdisciplinary approach, which geography can provide based on its subject of study. In this course, students can gain basic knowledge about the environment, its elements,

develop environmental awareness and responsible attitude towards the environment and learn how to behave in an environmentally friendly and sustainable manner. Development of intellectual abilities is encouraged and emotional and volitional aspects of personality development are engaged through interaction with the environment and encouragement of the research-based approach to teaching. A holistic approach to understanding the environment, environmental problems and ways to solve them, as well as to education, developing students' potentials, co-operation between school and the local community is a starting point for the creation of learning strategies in teaching geography which regards sustainable development as a starting point and a goal. Key subject matter on sustainable development, which is an integral part of the geographic content, should be considered from both interdisciplinary and thematic perspectives. One of the outcomes of learning for sustainable development is a competent and active individual that has knowledge, developed awareness and responsibility for processes and changes in the natural and social environment and who is ready to take on complex roles in life.

A change in the paradigm of teaching and learning stands out among changes based on the concept of sustainability. Education for sustainable development requires that the focus of education be redirected from the concept of transferring knowledge towards the concept of knowledge construction, which brings in the foreground the active nature of the process of learning. At the same time, emphasis is placed on the construction of knowledge by the student (self-activity) and the importance of interaction with the environment is particularly highlighted. Therefore, in addition to giving lectures, teachers who teach geography should apply as many methods and forms of work as possible to put students into the position of active constructors of their knowledge. These include learning strategies through problem solving, integrated learning, integrated classes outside classroom, classes focused on performance, research-based instruction, cooperative learning, and project-based teaching.

The traditional concept of formal education based on individual classes must be upgraded starting with the basic principles of sustainable development by applying interdisciplinary and out-of-classroom approaches to teaching. This means that through interdisciplinary linking of concepts and subject matter (both within the same subject and cross-curricular) and increasing the share of out-of-classroom teaching (learning outside the classroom), great strides can be made in acquiring applicable

knowledge, skills and attitudes which can help students take active part in the society.

If "the development of key competencies based on acquired knowledge, which could enable students to recognize situations in which their academic knowledge may be relevant" (Baucal, 2012) is distinguished as one of the goals of teaching, then geography as a school subject has great potential for developing these competencies. These facts imply changes in the concept of teaching based on the behavioural concept, primarily regarding the transfer of information and "lecture-based teaching". One way to achieve this goal is to create as many teaching situations in the immediate natural and social environment, where a participant is placed in a position to think, research, link, classify, see connections between phenomena and processes, understand the causal links and relations and has a critical attitude towards what they have learnt (Andjelkovic&Stanisavljevic Petrovic, 2013). Creating teaching situations in the natural and social environments outside school is an integral part of the education of geographers. In this regard, a number of authors point to the importance of creating a link between the context and a process of learning, while emphasizing the importance of the elements of the physical context (Falk&Dierking, 2013; Rickinson, 2004; Tunnicliffeetal, 1997; Barkeretal, 2002; Ivic et al., 2001). The linking of subject matter of learning to the context in which it will be used (Kelley&Kellam, 2009) is an important determinant of changes in the process of teaching and learning.

Geography lessons are rich in a variety of subject matters whose nature provides a new approach to learning through the construction of knowledge. In this regard, the importance of natural and social resources as teaching and learning environments (archaeological sites, nature, forests, national parks, museums, geographical sites etc.), as the source, means and object of study is emphasized. In this paper, we attempt to examine the relevance of the subject matter of geodiversity and geological heritage for the teaching of geography, with special emphasis on the value of the acquisition of knowledge, skills and attitudes through field learning and teaching, at sites where students can experience direct contact with the objects of their study.

Geodiversity and geoheritage in Geography teaching as resource for teaching and learning about sustainable development

Before embarking on the analysis of the representation of the subject matter of geodiversity and geoheritage in geography curricula in

elementary and secondary schools in Serbia, as well as opportunities for new methodics and didactic formation and study, we will look at the definition of these terms. "Geodiversity is the geographical diversity of the landscape manifested as its geological structure and morphological elements and processes. In addition to rocks, geo-morphological features and land, geodiversity includes various hydrological and climate processes which modify them" (Ljesevic, Dragicevic, Milanovic, Obradovic Jovanovic and Novkovic, 2009: 78). "Serbian geoheritage encompasses all geological, geo-morphological, pedologic and special archaeological values created during the formation of the lithosphere, its morphological shaping and interdependence of nature and human culture, which, because of extraordinary scientific and cultural importance, as well as a unique geological heritage of Europe and the world, must be a matter of specific concern to all social factors in Serbia" (Nature Protection Act, 2010). According to Simic, Gavrilovic and Djurovic (2010), a well-rounded, comprehensive and complete definition of geoheritage must include, in addition to geological, geo-morphological, pedologic and special archaeological values, climate and hydrological values, which are certainly the subjects of its research and study.

Geography content related to sustainable development from the aspect of subject matter of geodiversity and geoheritage is directly mentioned only in the eighth grade within the teaching units "Protection of geoheritage, air, water, soil, plants and animals" and "Protected nature sites and the national parks of Serbia" and in the secondary school curriculum for the third grade in the teaching unit "Protecting and promoting the elements of the environment". Indirectly, this content is presented in the fifth and sixth grade of primary school and in the first grade of grammar school in relation to Earth spheres, when students are introduced to structures, phenomena and processes in all four spheres, intra and inter-sphere connections as well as specific physical and geographical principles. This matter is also dealt with within the framework of regional geography in the sixth and seventh grade of primary school and in the second grade of grammar school in regards of Europe and other continents, and in the eighth grade of primary school and in the third grade of grammar school when it comes to national geography. It can thus be seen that the subject matter in this field, given its importance for the development of the concept of sustainability, is very poorly represented in the curricula. Voluminous subject matter, along with only few classes available to cover it, is certainly an objective reason for the prevalence of traditional teaching methods in the realization of this subject

matter (in the fifth grade, only one class per week is planned for geography, while only two classes per week are planned in the sixth, seventh and eighth grade of primary school and in the first, second and third grade of grammar school (annual class load of 74 classes). Although the curriculum prescribed by the Ministry of Education suggests that geography teachers should insist on the prevention and protection of nature (both animate and inanimate) in order to prevent the disturbance of its balance, there is a question of how this goal can be achieved in geography classes? Are students in a position to construct knowledge on their own or are they always in a position of passive recipients of ready-made knowledge? What kind of outcomes should we expect from such education? It is clear that a path of reorganization of geography teaching lies before us, with an emphasis on increasing the share of research-based teaching and experiential learning in the field both in regular classes and through field work, projects, research, field trips and visits aimed at constructing competencies for sustainable development.

While many geoheritage and geodiversity sites are located near schools or in the local environment, it is as if teachers cannot recognize their teaching potential and still insist on studying such subject matter from textbooks. The experience of such sites and a direct contact of students with objects of learning determine the quality of the teaching process. In this regard, it is very important that teachers be well acquainted with local surroundings and their teaching potentials as a means and objects of learning.

Geoheritage and geodiversity sites, which in the context of this paper are understood as locations and resources for research and teaching, are hardly ever used for such purposes. This is indicated by findings of surveys conducted among teachers who attended a teacher training seminar "Integrated Out-of-classroom Teaching". Out of 651 geoheritage sites identified in Serbia, 29 of them are located in Iron Gates, 86 in the Serbian Danube Basin and 8 in the city of Belgrade. This is a very large number, but there is a plan to further expand the list of geoheritage sites. However, in the City of Belgrade, only a small number of classes, both in primary and secondary schools, have been taught at such sites. The reason behind this is that there are not enough classes provided for such topics in the curriculum as well as the fact that teachers have limited knowledge of teaching and didactic methods related to the possibilities of using such sites as means and sources of learning.

Development of general cross-curricular, general and subject-specific

competencies of students at geoheritage and geodiversity sites

The quality and efficacy of the teaching process as well as learning outcomes and students' competencies are integral and important elements in the process of ensuring good quality education. In that regard, changes towards the development of the curricula based on competencies that students require in order to be able to participate actively in the society and lifelong learning have been taking place at all levels of education. The findings of international surveys in the field of education such as the Programme for International Student Assessment (PISA) in which Serbia has been taking part since 2001 indicate, among other things, that students from Serbia achieve rather poor results, particularly with regard to functional skills. In this context, a paradigm shift from the behaviourist to the constructivist approach to teaching and constructing students' competences provides a basis for making changes at the level of curricula and syllabi, teaching content, textbooks and the level of competence of teachers. One of the aims of this approach would be to make a change in the outcome of the teaching and learning process manifested through students' competences. There are great possibilities for applying the interdisciplinary approach and developing new learning outcomes as part of geography classes. Such an approach leads to the introduction of general cross-curricular as well as general and subject-specific competencies. According to the Curriculum Framework for Mandatory Subjects in Secondary General Education, general cross-curricular competencies include the learning competency, responsible participation in a democratic society, aesthetic competency, communication, responsible attitude towards the environment, responsible attitude towards health, venturesomeness and entrepreneurial spirit, ability to work with data and information, problem-solving, cooperation and digital competence (Razvionica, 2015). Only the indicators of cross-cultural competencies that are developed by acquiring content related to geodiversity and geoheritage in correlation with other school subjects will be discussed in this paper.

The development of communicative competences is facilitated by finding information and interpreting facts about geodiversity and geoheritage from national and international literature, geography maps, information technology and working in the field. Their study within the scope of geography lessons can be correlated to the content of biology in terms of historical and geological sites (profile of Carboniferous olistromes – Avramac creek valley)

and stratigraphic heritage (profile with reef fauna, Maastricht - Cerevicki creek valley, Fruska Gora), which are singled out because of numerous fossils from the Paleozoic, Mesozoic and Neogene periods (profile with an abundance of fauna from the Middle Baden stage - along the road to Donji Milanovac). This correlation allows for a better understanding of the main characteristics of the biosphere in the earlier geological periods, from when life first appeared on Earth until the moment first humans emerged. A correlation with physics lessons is possible when dealing with petrological heritage and geoheritage sites related to the Neotectonic activity and geophysical phenomena (visibly slower propagation of seismic waves - Deliblato Sands). This may explain the effects that the endogenous forces, the gravity and the internal heat of the Earth have on the epirogenic and orogenic movements which lead to the formation of the largest forms of the relief, such as continents, ocean basins, mountains and plains. A correlation with chemistry lessons is possible when covering the topic of hydrological heritage (the artesian well in Ovca, a village near Belgrade), where it is possible to do water chemism of a given source. A correlation with history lessons can be established when processing archaeological geoheritage sites (such as the archaeometallurgical complex of mining operations of the oldest copper exploitation in the Balkans – Rudna Glava, near Majdanpek). In addition, correlations can also be made when covering history topics related to Middle Age forts and towns built by using specific types of stone quarried nearby such sites or brought from pits located at different distances from those sites. Content thus complex can be acquired most suitably by implementing projects in the field, which is why geography can successfully correlate with physical education. The development of mathematical literacy and a correlation with mathematics is reflected in understanding the forms of geoheritage as elements on a geographical map, determining their coordinates, mutual distance, remoteness, absolute and true altitude, thereby developing the skills of measurement, comparison and classification. These skills are developed primarily through individual work or cooperation between students in the field, where they can use instruments and develop their skills.

If the mechanisms of influence of social factors on geodiversity and geoheritage are explained based on scientific facts, this will enhance the understanding of the changes brought about by human actions in the natural environment and development of responsibilities for the preservation and improvement of the living environment. The best negative example of this is the lake and the bay in Sremcica, not far from the centre of Belgrade,

where due to human negligence, a representative example of karst landforms and hydrography has been left derelict, polluted, overgrown in marsh vegetation and completely out of reach of visitors. Outstanding results in building competencies for sustainable development are achieved by integrating field classes and modern educational technology. A latitude, longitude and elevation or relative altitude of each geoheritage site can be precisely defined by using the GPS; it can also be used for navigation, while other forms of information technology can be used to collect, process and present geoheritage data. In this way, students improve their digital literacy and competence, while establishing a correlation with computer science and IT. For instance, by collecting geographic coordinates of geoheritage sites in Iron Gates via GPS and processing them using GPS software, it is possible to create a thematic map that could be used to analyze the given area and solve research tasks in the field.

As a result of thus designed geography classes, all students' potentials, cognitive and emotional, volitional and physical, can be realized; the end result is represented by students who are able to participate, in cooperation with others or as a member of a group, in joint problem solving or realization of joint projects, who can partake responsibly in school life and community they belong to, as well as in the broader democratic society, guided by the rights and responsibilities they have as members of the community and citizens.

Geography curriculum related to geodiversity and geoheritage, their spatial distribution, diversity, individuality and connectivity in the geographical environment can increase knowledge and skills related to identification, explanation and resolution of problems, both at the personal and the social level (environmental problems, sustainable economic development etc.) and can be realized through problem-based learning in correlation with biology, sociology and civics education classes. Content related to geodiversity and geoheritage prompts students to adopt views about the need to preserve and improve all elements of their immediate and wider environment. It also helps them understand the activities that lead to air, water and land pollution and their harmful effects on human health and encourages them to show a willingness to engage in activities aimed at preserving the environment. In this process, students adopt autonomous aesthetic criteria.

Geoheritage sites, as representative examples of geological diversity, certainly do facilitate the development of aesthetic competencies in students. Such competencies can also be promoted to a greater or lesser degree by correlating geography with the subject matter of visual arts education. Examples of this are the Iron Gates Gorge, the Boljetinska River,

natural bridges across the rivers Vratna and Zamna, Beli Izvorac tufa accretion, etc. (Institute for Education Quality and Evaluation, 2015).

Examples mentioned above in which geodiversity and geoheritage are perceived from two perspectives, as subject matter of geography teaching and a place or a context of an interdisciplinary approach to teaching, contribute to the development of general subject competency and subject-specific competencies for geography as defined by the Rulebook on General Standards of Achievement at the End of Secondary General Education and Secondary Vocational Education for general education subjects and general cross-curricular competencies. Learning outcomes related to geodiversity and geoheritage contents within the framework of development of general subject competencies entail that "a student has acquired an ability to apply practical skills and use instruments in order to orient themselves more easily in space and time and to apply geographic knowledge about the elements of the geographic environment, their development, interrelations, links, conservation and rational use for the purpose of planning and improving personal and social needs and national and European values". The student has also developed subject-specific competencies related to the application of geographic skills when organizing activities in space and time and use of geographic knowledge to participate in community life in an active and responsible manner (Official Gazette of the RS, 2013).

To allow for development of students' competencies, a series of changes need to be made in the existing educational practice at all levels. One of the changes concerns the role of the teacher. The concept of sustainability defines new, more complex roles for teachers. In this respect, the initial education of geography teachers and their lifelong professional development and training need to encourage the problem and research-based approach to teaching and development of critical thinking in teachers. Similarly and in keeping with the new constructivist approach, geography teachers must apply a variety of teaching methods which comply with the aims, outcomes and achievement standards, contents of the subject and characteristics of the age and individual abilities and needs of their students. Teachers should pay special attention to fostering close cooperation with students which should result in joint constructions of new knowledge by adopting the problem-solving and research-based approach to learning (Cindric et al., 2010). The nature of geography teaching in Serbia indicates a need for a change of paradigm by shifting the focus away from the actions of teachers and towards what students do, how and why, while

putting emphasis on learning outcomes in order to acquire competences for sustainable development.

Conclusion

The paper points to educational potentials of geoheritage and geodiversity that are recognized in geography lessons as a source, the agent and the subject of instruction and learning whose aim is to foster the acquisition of competencies for sustainable development. The implications of our theoretical discussion of the present issue can be viewed at both macro (systemic changes at level of statutory regulations) and micro levels (changes in teaching geography).

The above discussion indicates that there is a need to amend statutory regulations to increase the weekly and annual geography class load both in primary and secondary vocational schools as well as grammar schools. Also, geography classes should be introduced into the curriculum of the fourth grade of grammar school. By making such changes to the curriculum, more time would be allowed for covering geoheritage and geodiversity-related contents. Also, changes need to be made at this level not only in respect of geography curriculum, but also in respect of other subjects with the aim of fostering interdisciplinary and thematic planning. Such changes would have a direct effect on the quality of teaching with regard to acquiring functional and procedural knowledge; they would result in an increase in the share of out-of-classroom classes and in the use of field trips and visits to such sites for doing projects and research papers; the use of different active methods and forms of work would also increase; such changes would also lead to linking the teaching of theories in the classroom with research on the field and geodiversity sites; the roles of teachers and students would also undergo a change.

By pointing out the benefits of changes in the study of the content of geodiversity and geoheritage to the educational and professional public and to practitioners leads to answering the question "How can we make the teaching of geography more interesting and more purposeful"? The answer can be found in improving the quality of teaching starting from the basic tenants of the constructivist learning theory and by pointing out the advantages of teaching outside the classroom when covering geographic content that is a good link between the classroom and the real world; it is also an important way of learning and a substantial segment and determinant of geography (Fuller et al., 2006). The ultimate goal is to create a culture of quality geography teaching based on clear evaluation of learning outcomes that is focused on students and their competencies. We will be facing a process of

critical review of the existing practice of geography teaching in Serbia and its enrichment with modern approaches concerning the design of the curriculum in order to realize the concept of education for sustainable development.

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Assessment of Nutritional Status and Deficiency Disease through Geographical Survey: A Case Study of Varanasi District in India

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Abstract

Identifying the role of the diet at the start of many diseases and evaluating the nutritional status of an individual, family and community is significant for public health. The main objective of this paper is to geographically evaluate the nutritional status and deficiency disease in the development blocks of Varanasi district, India. Primary data are collected from 800 respondents of 16 selected villages (2 villages from each development block) in the rural part of Varanasi district and their results are analyzed with the help of SPSS statistical software. The study involved geographical survey based interviews using a questionnaire, measurement of nutrient intake and assessment of their general knowledge and awareness about nutrition and deficiency diseases on the basis of their occupational structure, house type and income status.

The findings of this paper also show that the socio-economic status of the respondents is closely related with nutritional status of people living in the rural areas of Varanasi district. It is interesting to note that about 15% of household's intake is still less than 1500 calories per capita per day, which leads to malnutrition and deficiency diseases. More than half of the respondents of the study area are found to be suffering from nutritional deficiency diseases.

Keywords: *Varanasi, nutritional status, deficiency disease, SPSS*

Rezumat. Evaluarea stadiului nutrițional și bolilor generate de deficiențe nutriționale prin studiu geografic: studiu de caz districtul Varanasi, India

Identificarea rolului pe care îl are dieta pentru declanșarea diverselor boli și evaluarea modului de nutriție al unui individ, sau al unei familii și comunități este extrem de important pentru sănătatea publică. Obiectivul principal al acestei lucrări îl reprezintă evaluarea geografică a stadiului nutrițional și bolilor nutriționale din blocurile de dezvoltare din districtul Varanasi, India. Datele primare au fost colectate de la 800 de respondenți din cele 16 sate selectate (câte 2 sate din fiecare bloc de dezvoltare) în zona rurală a districtului Varanasi, rezultatele fiind analizate cu ajutorul programului SPSS. Studiul are la bază analiza aportului zilnic de calorii așa cum rezultă din chestionarele aplicate și evaluarea nivelului de conștientizare cu privire la nutriție și bolile de nutriție în funcție structura socio-economică, tipul de gospodărie și nivelul veniturilor.

Rezultatele lucrării arată că aportul nutrițional este strâns corelat cu nivelul socio-economic al respondenților din zona rurală a districtului Varanasi. Este interesant de menționat faptul că aproximativ 15% din gospodăriile au un aport zilnic mai mic de 1500 de calorii/ zi, ceea ce favorizează apariția bolilor de nutriție și a malnutriției, peste jumătate din persoanele intervievate suferind de o boală de nutriție.

Cuvinte-cheie: *Varanasi, stadiu nutrițional, boli de nutriție, SPSS*

Introduction

The nutritional status of an individual is typically a consequence of multiple factors that interrelate with each other at different levels. The consumption of suitable amount of food both in terms of quantity and quality is one of the important factors, which has a substantial influence on the nutritional status (Park, 2009). Income, prices, individual preferences and beliefs, cultural traditions, as well as geographical, environmental, social and economic factors all interact in a complex manner to shape dietary consumption patterns and affect the morbidity and clinical status of women (Mittal, 2013). A normal balanced diet must include daily foods from the various food groups in sufficient amounts to meet the needs of an individual and to increase immunity. The assessment of the nutritional status involves two methods: the former deals with individuals and measures the objective criteria, the latter uses community health indices reflecting nutritional influences (Beghin et al. 1998).

Availability and affordability of nutritional diet, backed by health and educational services in an environmentally sustainable scenario will then enable each member of the society to live a 'good' life, each individual personality getting an opportunity to flower to one's full potential. A large variation in defining 'adequate' food exists, ranging between 1400 and 2800 calories and therefore, it is subject to value judgment (Pasricha, 1971). The poor in rural areas who do heavy physical work in the field need much higher calorie intake than people with moderate activity, a fact which can swell the number of food insecure substantially" (Bapna, 1993).

Good nutrition is a rudimentary component of human health. The importance of nutrition is increasing in any country where nutritional diseases are extensively widespread. In community medicine, nutrition is measured as an important indicator of human health status. The effects of malnutrition on a community are both direct and indirect. The direct effect manifests in nutritional deficiency diseases, while the indirect effect is seen among people with

low vitality and arrested growth, high infant mortality, neo-natal and low birth rates and lower life expectancy at birth (Bedi, 1979).

The terms food and nutrition are sometimes used synonymously. Food is a composite mixture of various substances and the quality of which may vary from a few grams in certain cases to hundreds of grams in other (Brock, 1961). Nutrition on the other hand, signifies a dynamic process in which the food that is consumed by an individual is utilized for nourishing the body. It provides energy for work. Frequently, population diets are deficient in macronutrients (protein, carbohydrates and fat, leading to protein-energy malnutrition), micronutrients (electrolytes, minerals and vitamins, leading to specific micronutrient deficiencies) or both (Brabin and Coulter, 2003; Pinstrup et al. 1993; Levin et al. 1993; Millward and Jackson, 2004).

Energy, the fundamental requirement of the human body, is derived through consumption of food stuffs of required calorific value. Growing children and women during pregnancy and lactating period require some extra amount of energy. Under nutrition results in loss of weight and disturbances such as low basal metabolic rate, slow pulse, lower blood-pressure, suppression of menses for women, skin diseases, blood shot eyes etc. (May, 1974). Nutrient deficiency, burning sensation in the feet and hands and a sore throat with increase salivation are common symptoms in case of chronic starvation. A poorly nourished child suffers from the problems related with learning due to weak mental status (Park, 1992).

The caloric requirement depends upon nature of work, climate, age and sex. There is special requirement of calories during pregnancy and lactation period and pre-school stage. There have been significant improvements in the overall nutritional and health status of the population in India over the last two decades with a steady reduction in the percentage of underweight children and severely malnourished children, better early childhood care for survival, growth and development and better nutritional status of pregnant and lactating women (Ismail & Mustaqim, 2013). This paper aims to analyze the social and economic factors that influence the health and nutritional status and the role of primary health centers (PHC's) in abating deficiency diseases of people living in the rural area of the Varanasi district, India.

Nutritional deficiency disease

Malnutrition in children and women is a main public health problem in most of the developing countries and Protein Energy Malnutrition (PEM) is more common among under five year children (Bhandari & Chhetri, 2013; Bhatia et al., 1983). On account of malnutrition, a number of deficiency diseases occur among rural population. In this

context, it is pertinent to know the numerous deficiency diseases caused due to malnutrition (Devdas et. al., 1978). The types of deficiency and their reasons are as follows.

Protein-calorie deficiency disease: This is a common disease mainly in early childhood in India. Mild degrees of protein calorie malnutrition (PCM) result in growth retardation, while severe degree leads to (i) Kwashiorkor and (ii) Marasmus. Kwashiorkor is extreme degree of PCM especially in children in weaning and post weaning periods. The condition is considered mainly due to protein deficiency with adequate or more than adequate calories. The syndrome is characterized by oedema, growth failure, muscle wasting, mental changes, hair changes, dermatitis, anaemia and hepatomegaly. Condition of pre-kwashiorkor has also been recognized, which is characterized by severe wasting of a child. Diet is usually low both in calories and protein. The main clinical features are growth retardation, wasting of muscles and of subcutaneous fat. Protein deficiency among adults is also quite prevalent in poverty ridden areas like eastern Uttar Pradesh. Protein deficiency will result in adults in reduced weight, reduced subcutaneous fat, anemia, greater susceptibility to infections, frequent loose motions, general lethargy, delay in healing of wounds and oedema.

Mineral deficiencies: A number of deficiency diseases have been documented due to inadequate supply of minerals in food. These are (i) deficiency of iodine, in water and food leads to goiter, (ii) lack of fluorine (<0.5 ppm) in water leads to dental caries, (iii) calcium deficient diets leads to rickets and osteomalacia, (iv) iron deficiency diets lead to anemia, (v) there are other vital minerals like, copper, selenium etc. usually their requirements are also little. Generally, their requirements are very slight so that deficiency conditions do not occur.

Vitamin deficiency: Vitamin deficiency causes a variety of disease which are: (i) lack of Vitamin 'A' result in exophthalmia, Bitot's spots, night blindness and keratomalacia, (ii) B complex-deficiency of thiamine leads to beri-beri, (iii) vitamin C deficiency leads to scurvy, spongy bleeding gums, hemorrhages in skin and other hemorrhages, (iv) vitamin D deficiency results in rickets and osteomalacia.

Problem of over-nutrients: Over nutrition problems are particularly significant for affluent communities, families or individuals. The major ones are: (i) Obesity- The main features of obesity are overweight and fatness. It is frequently affected by overeating and abundance of calories, (ii) Hypervitaminosis A is at times caused by excess of vitamin A therapy. The manifestations of headache, nausea, vomiting irritability and anorexia, (iii) Fluorosis occur if fluoride is available > 1 ppm in water. It is characterized by (a) dental fluorosis, i.e., mottled

enamel of teeth and (b) skeletal fluorosis, i.e., dense bone formation; sever spondylitis and even calcifications of ligaments. Besides diseases of under-nutrition discussed above, nutritional anemia is related with under nutrition and cardiovascular diseases, e.g., hyper cholesterol, anemia etc. are associated with over-nutrition. The above-mentioned condition can be grouped under the problem of malnutrition.

The major identified causes of nutritional deficiencies are:

- **Biological cause:** The nutritional requirements of the human body may be considered as the products of man's adaptation to environmental opportunities in his evolutionary history. The balance between human, animal and plant population was so optimal that the chance of nutritional deficiency could at best be rare (Mishra, 1970).

- **The Man-Food ratio:** Availability of food is an important determinant of the nutritional level of population. Still, the increase in food production does not necessarily improve the nutritional status of a community. The structure of society and the manner in which production, distribution and consumption are organized are often equally, if not solely important factors. Therefore, to analyze nutritional deficiency does not mean assessing man-food ratio.

- **Cultural causes:** Cultural factors are also important in determining the nutritional status of the population living in a spatial unit. Polluted drinking water, unhygienic living conditions and may other similar factors may create conditional malnutrition.

To analyze the nutritional deficiency in the study area it is necessary to assess the nutritional status. It helps in conceiving a strategy for mitigation diseases due to malnutrition.

Geographical location of the study area

The study area is Varanasi district, the eastern district of Uttar Pradesh state, India which extends between 25°10' N to 25°37' N latitude and 82°39' E to 83°10' E longitudes, with a total area covering about 1535.11 sq. km. (fig.1). Administratively, the study area includes two tahsils, namely, Pindra and Varanasi Sadar; which are further sub-divided into eight Development Blocks, namely Baragaon, Pindra, Cholaipur, Chiraigaon, Harhua, Sevapuri, Araziline and Kashi Vidapeeth, consisting of 1336 villages altogether. The Varanasi district has a total population of 3,676,841 people with 1,921,857 males and 1,754,984 females, compared to 2001, when Varanasi had a population of 3,138,671 people with 1,649,187 males and 1,489,484 females.

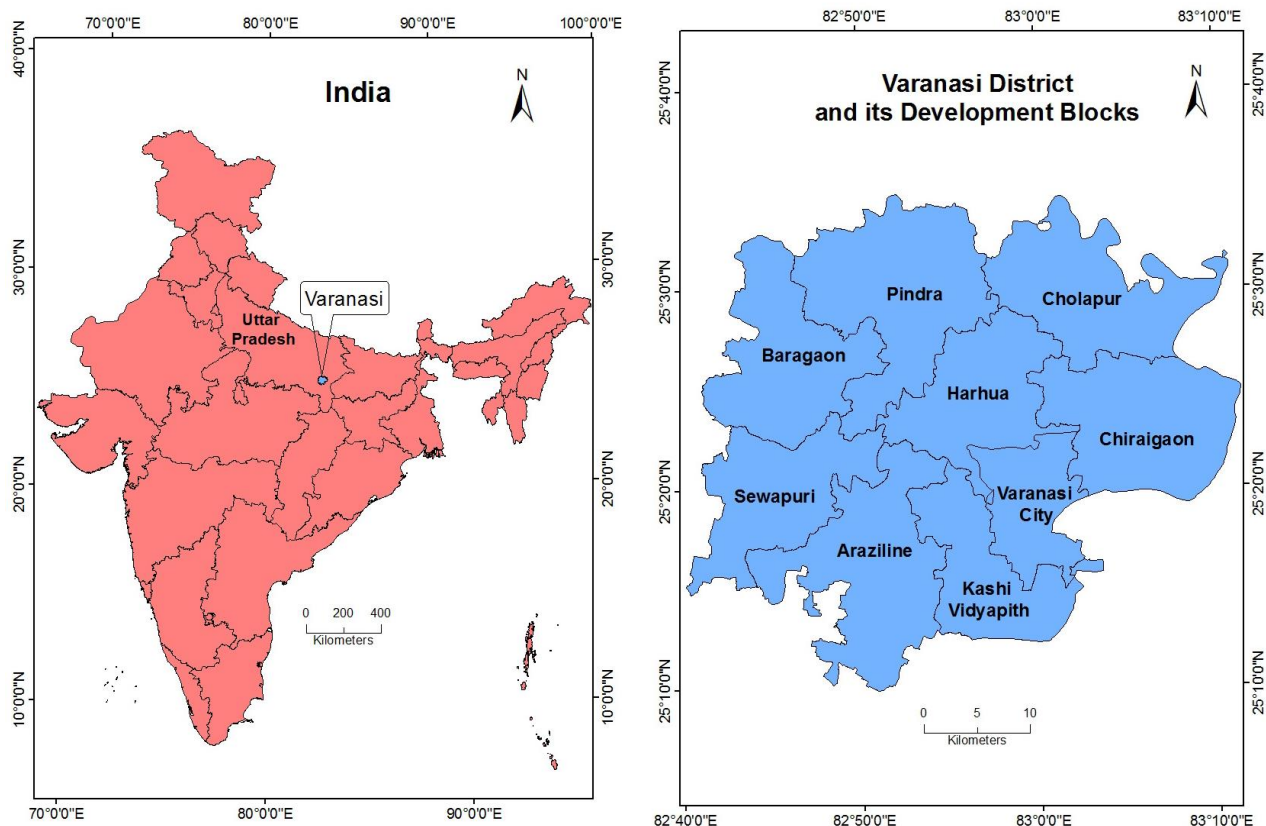


Fig. 1: Geographical location of the study area

Data used and Methodology

A common problem regarding the factors that influence health is the availability of data for geographical analysis. Secondary data related to health care facilities are collected from the chief medical officer (CMO), Varanasi district and also updated through global positioning system (GPS).

The data was collected through sampling and survey method. Primary data in the field are collected from 800 respondents out of 50 families from the 16 selected villages (2 villages from each development block) in the rural part of Varanasi district (fig. 2) to analyse the nutritional status and deficiency disease.

Food consumed by an individual or a family during the past 24 hours was registered. Further amount of different food items consumed by each

household has been converted into calories. The study involved interviews of respondents living in the study area through a personal questionnaire, measurement of food/nutrient intake, and assessment of their general knowledge and awareness about health, nutrition and deficiency diseases. The outcomes of the geographical survey are analysed with the help of SPSS software.

Results and Discussions

In the present study, the assessment of nutritional status within the study area has been made examining the diet of selected inhabitants from the sample villages.

Table 1 shows village wise number of households lying in different categories of calories consumption. Nutritional status is measured in terms of per capita calories intake in each of the households.

Table 1: Status of nutrition of the selected sample household in the study area

Development Blocks	Villages	Calories intakes (per capita)						Total Respondents
		<1000	1000-1500	1500-2000	2000-2500	2500-3000	>3000	
Baragaon	Bashni	-	7	30	9	4	-	50
	Belwa	1	10	22	10	6	1	50
Pindra	Ajaipur	-	6	26	10	6	2	50
	Goghri	2	11	27	8	2	-	50
Cholapur	Sugulpur	-	1	31	13	2	3	50
	Rampur	-	1	31	13	5	-	50
Chirai Gaon	Sandaha	-	1	28	14	5	2	50
	Bankat	2	9	19	19	1	-	50
Harhua	Purai Kala Harhua	1	7	25	14	2	1	50
	Maghaipur	-	5	27	15	3	-	50
Sewapuri	Sakalpur	1	1	23	18	5	2	50
	Ishawar	-	10	24	12	4	-	50
Araziline	Jakhini	-	9	26	9	5	1	50
	Burapur	2	12	23	11	1	-	50
Kashi Vidhyapith	Anantpur	-	8	26	12	3	1	50
	Sir Gobardhan	1	7	23	12	4	3	50
Total		10	105	411	200	58	16	800

Source: Based on Personal Survey & Self Computed, 2016

Out of the 800 households, only 10 (1.25%) are lying in the class interval of less than 1,000 calories per capita intake, while 105 households (13.12%) come to the category of 1000-15000 calories. Furthermore, 411 households (51.37%) belong to the category of 1500-2000 calories and 200 households (25%) in the groups of 2000-2500 calories. The study reveals that 65% to 75% household's intake is less than 2000 calories per

capita per day. It is interesting to note that 14.37% household's intake is even lower than 1500 calories per capita per day, which results in malnutrition and deficiency diseases. The maximum number of households (31) which are consuming less than 2000 calories/capita/day are identified in village Sugulpur of Cholapur block, while the minimum (19) from Bankat village of Chiraigaon block (fig. 2).

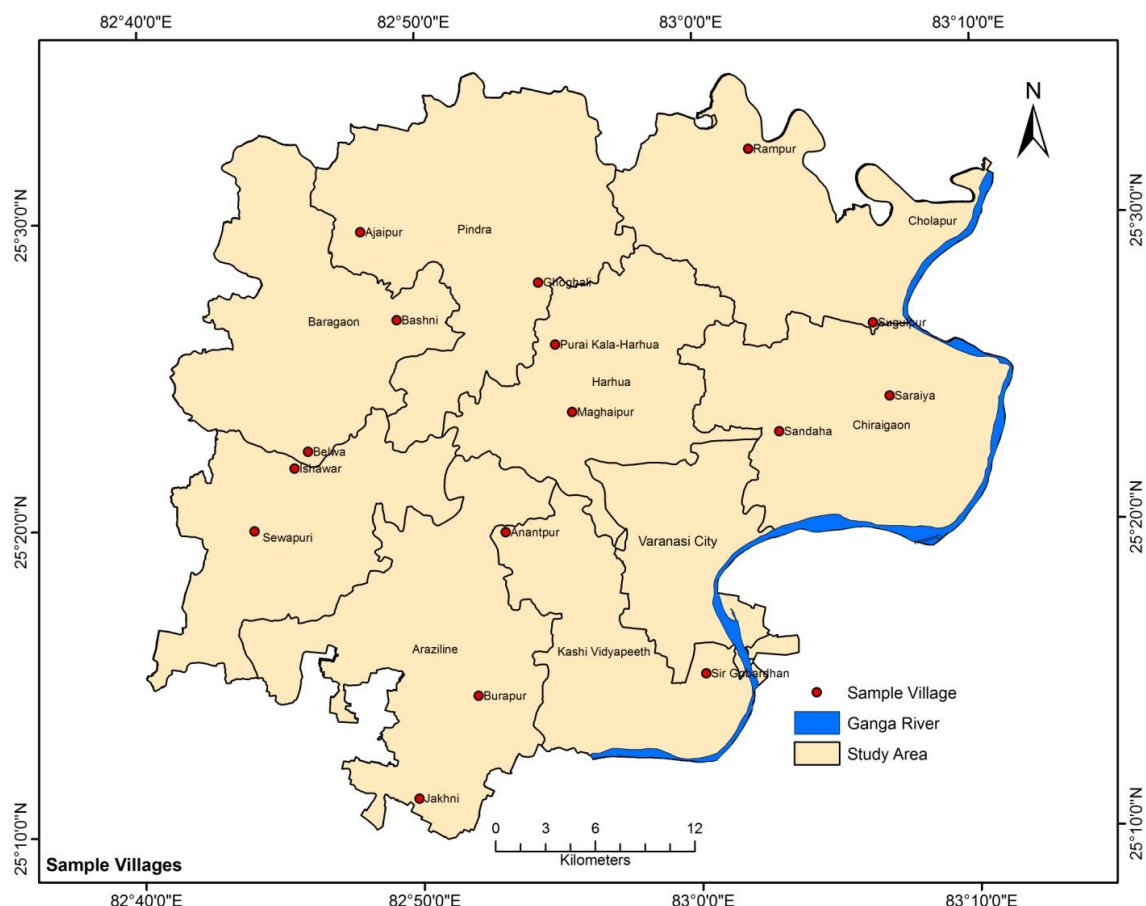


Fig. 2: Sample villages collected through GPS selected for survey in rural part of Varanasi district

Furthermore, 58 households (7.25%) are in the category of 2500-3000 calories and 16 (2%) are in the group of more than 3000 calories. Thus, it can be seen that 89.5% of the sample households are in the class interval of 1000-2500 calories intake per capita. The analysis reveals that a significant number of households consume less than 2500 calories (2400 calories essential for an adult person). Village wise variation in calories intake by individual household also reflects the sample pattern. In all the villages half of the surveyed households get less than 2000 calories per capita

per day. This means that a considerable part of the rural population within the study area is underfed.

Nutritional status according to occupation wise

To analyze the relationship between the nutritional status and occupation, data were processed and put into a table. Table 2 presents the nutritional status by occupation of the sample population. Occupations are classified into 5 categories. They are laborers, cultivators, agriculture with cottage industry, agricultural with services and services. Out of the total 250 laborers, 80% get less than 2000 calories per day.

Table 2: Occupation type wise nutritional status

Occupation	Calories intake						Total Respondents
	<1000	1000-1500	1500-2000	2000-2500	2500-3000	>3000	
Labourers	5	50	145	50	-	-	250
Cultivators	3	72	176	45	-	-	266
Agriculture based Cottage Industry	2	15	50	48	2	2	130
Agriculture with Service	-	5	30	33	6	6	89
Others	-	3	10	2	8	8	65
Total	10	105	411	200	16	16	800

Source: Based on Personal Survey & Self Computed, 2016

During the study, it is seen that about 20% of interviewed laborers have an intake of 2000-2500 calories per capita per day.

Among the 266 cultivators, 94.36% get less than 2000 calories per day, whereas 16.91% consume 2000-2500 calories per day. Of the total 89 respondents engaged in agriculture and services, 39.32% consume less than 2000 calories per day, whereas 60.67% get more than 2000 calories of food per day. Out of the 65 respondents working in services, 46.15% consume more than 2000 calories per day. The above analysis highlights that those engaged in services along with support of agriculture get better nutrition than the persons working as cultivators and laborers.

Nutritional status according to house type wise

Table 3 presents the nutritional status by house type of the sampled households. Out of the total 800 respondents, 266 have uncemented (kachha) house, of which more than 88% consumes less than 2000 calories of food per day.

During the analysis, it is clearly seen that the 275 households in the study area come under cemented houses category (34.37 % of the total), while 259 households occupying mixed type of houses get less than 2000 calories per day. The analysis proved that there is some association between the nutritional status and type of houses, i.e. households with non-cemented houses, reflecting their poor economic condition, are unable to afford more than 2000 calories per capital per day.

Table 3: House type wise nutritional status in the study area

Type of House	Calories intake						Total Respondents
	<1000	1000-1500	1500-2000	2000-2500	2500-3000	>3000	
Non Cemented	7	75	153	20	10	1	250
Cemented	1	20	126	85	13	10	275
Mixed	3	10	132	95	15	5	259
Total	10	105	411	200	58	16	800

Source: Based on Personal Survey & Self Computed, 2016

Nutritional status according to income

The level of income in any community affects the dietary pattern. The survey reveals that nutritional intake of lower income groups (below Rs. 2000) are mainly based on cereals. They have very low intakes of leafy vegetables, ghee and oils and non-vegetarian foods. The dietary pattern of middle class (Rs.3000-Rs. 6000) consists of higher intake of cereals and lower intake of protective foods in comparison to the ICMR recommended balanced diet (ICMR 1975). In terms of calories intake, out of 263 respondents belonging to low income group, maximum percentage of villagers (61.97%) take 1500-2000 calories of food per day, whereas about 11% of respondents' intake exceeds

2000 calories per day. It reflects their poor economic condition.

Table 4 shows that out of the 275-middle income-group respondents, about 58% have an intake of less than 2000 calories per day, whereas 50.60% of respondents belonging to high income group (greater than Rs. 6000) consumes less than 2000 calories per day. It reflects their poor economic condition. The data further reflects that more than 50% of the interviewed persons have a daily intake less than 2000 calories. Thus, it is obvious that the socio-economic status of the respondents is closely related with the nutritional status of people living in the rural areas of Varanasi district.

Table 4: Income wise nutritional status in the study area

Type of House	Calories intake						Total Respondents
	<1000	1000-1500	1500-2000	2000-2500	2500-3000	>3000	
<3000	6	65	163	19	9	1	250
3000-6000	3	25	132	96	16	4	275
>6000	1	15	116	85	33	11	259
Total	10	105	411	200	58	16	800

Source: Based on Personal Survey & Self Computed, 2016

Status of nutritional diseases

The quality and quantity of food which people get in general may be correlated with the nutritional deficiency diseases. A particular nutritional deficiency disease may not necessarily be due to just one nutrient element. It may occur due to the deficiency of more than one nutrient in the diet taken concurrently by a section of the population for a considerable period. Similarly, the deficiency of one nutrient, usually, may not necessarily lead to only one particular disease. The deficiency of one or more nutrients may produce different diseases in accordance with varying degree of nutritional deficiency, human resistance, difference in climatic condition, differences of food items at a place from one period to another (Mishra 1970). In this context, an attempt has also been made to evaluate incidence of nutritional deficiency diseases in the study area.

Table 5 reveals that out of the total 800 households surveyed, for 56.75% of the households, one or other member of the family are found to be suffering from nutritional deficiency diseases. Vitamin A deficiency contributes to anemia by immobilizing iron in the reticuloendothelial system, reducing haemopoiesis and increasing susceptibility to infections and it is essential for the functioning of the eyes as well as the immune system (Fleming and De Silva 2003; Semba 1998). Typically, vitamin A deficiency develops in an environment of ecological, social and economic deprivation, in which the key risk factors for vitamin A deficiency are a diet low in sources of vitamin A (i.e. dairy products,

eggs, fruits and vegetables), poor nutritional status, and a high rate of infections, in particular, measles and diarrhea diseases. Most of the persons (22.62%) in the study area were suffering from anemia, iron deficiency diseases. Their share varies from 8.30% in Harhua block to 18.20% in Chirai Gaon block. The analysis of the data clearly reflects that some of the respondents of the development blocks in the Varanasi district are also affected by Vitamin C deficiency disease. The maximum incidence of scurvy disease (18.30%) was recorded among respondents belonging to Kashi Vidyapith block, while the minimum (7%) in Chhapra, Harhua and Sewapuri development blocks. Additionally, the occurrence of beri-beri, a complex deficiency disease varies from 7.30% in Chirai Gaon block to 17.9% in Bara Gaon block. Less occurrence of Beri-beri diseases in Chirai Gaon development block is perhaps due to availability of fruits. This development block in Varanasi is very well-known for fruits like guava, lemon, mango etc.

Goiter is an iodine deficiency disease which is also predominant in the study area. It is a furthest visible appearance of iodine deficiency; others include hypothyroidism, decreased fertility rate, increased perinatal death and infant mortality. Table 5 shows that 9.65% respondents stated that at least one member of their family is suffering from this disease. The maximum incidence of goitre (14.5%) was recorded in Kashi Vidyapith block, while the minimum (10.14%) in Harhua development block.

Table 5: Development block wise status of nutritional deficiency disease

Development Block	Calories intake (per capita)						No. of Diseased Persons	Total Respondents
	Goitre	Rickets	Anemia	Night Blindness	Beri-Beri	Scurvy		
Bara Gaon	9	5	23	2	10	11	60	100
Pindra	10	4	22	2	9	11	58	100
Chhapra	7	1	16	1	7	5	37	100
Chirai Gaon	11	3	34	3	6	7	64	100
Harhua	7	2	15	1	8	5	42	100
Sewapuri	8	2	18	1	8	5	42	100
Azila	8	4	21	1	13	10	57	100
Kashi Vidyapith	9	2	25	2	9	13	60	100
Total	69	23	174	13	70	71	420	800

Source: Based on Personal Survey & Self Computed, 2016

Only 19 respondents from the study area were suffering from night-blindness because of vitamin A

deficiency. Low incidence of this disease is caused due to distribution of vitamin tablets by primary

health centers (PHCs) or sub-centers in the rural area of the development blocks.

Within the rural areas of Varanasi district, health care services are being provided through the network of primary health centers (PHC's) and sub-centers. The location of government health care units in the development blocks of Varanasi district is shown in the Fig 3. The rural people always use these health care units if any issue arises during the nutritional deficiency diseases or any health-related

problems. The government provides curative, preventive and primitive health services facilities through PHC's and sub-centers. PHC's provide a variety of services, while the sub-centers only family welfare facilities and some primary treatment (Rai and Nathwat 2014). The above analysis exposes that the incidence of nutritional deficiency diseases varies from one block to another depending upon their socio-economic conditions.

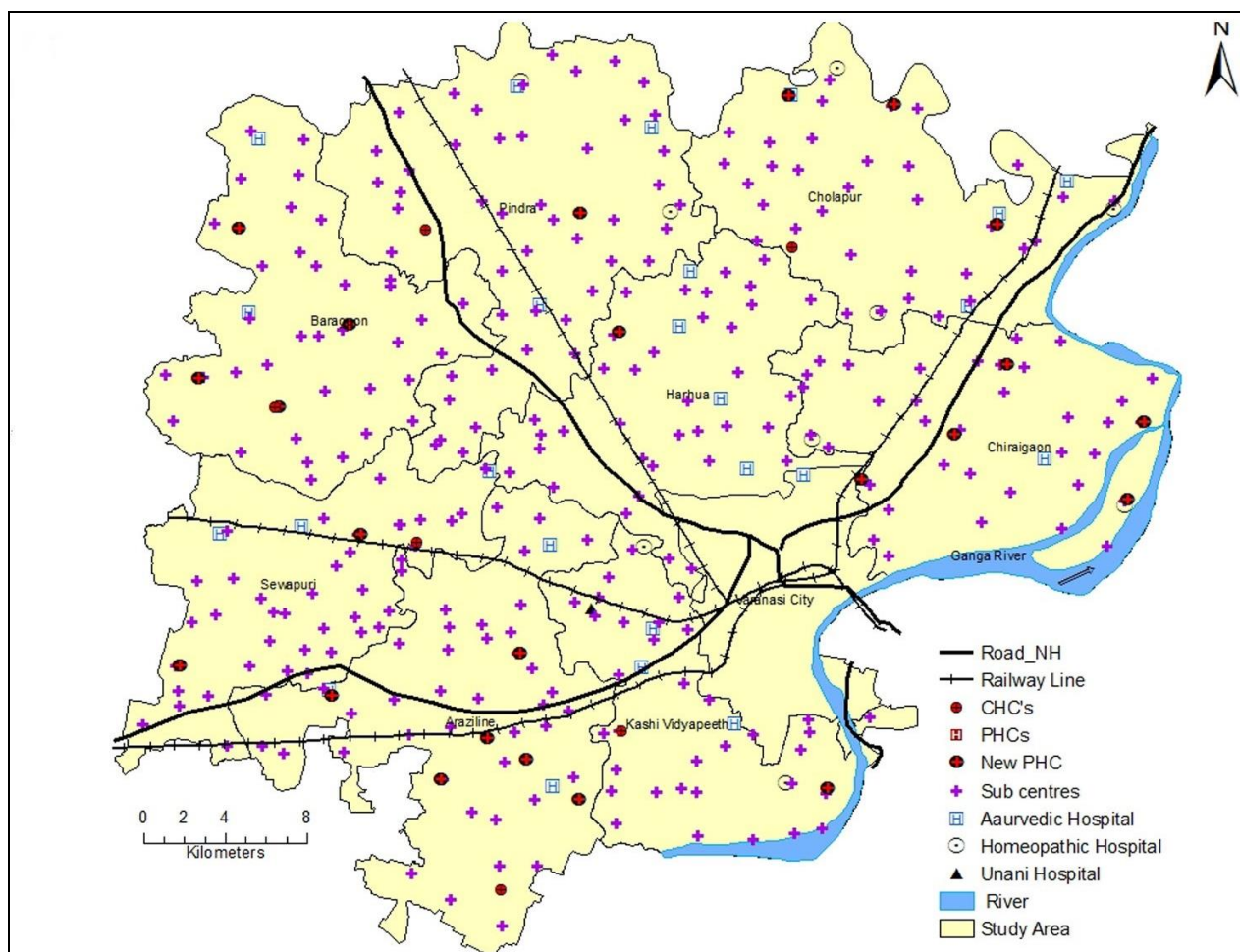


Fig. 3: Location of government health care units collected through Global Positioning System (GPS) (Rai and Nathwat 2014)

Conclusions

Diet-based strategies are probably the most promising approach for a sustainable control of micronutrient deficiencies. In the present study, the assessment of nutritional status within the study area has been made by using dietary examination method of selected inhabitants of sample villages. The analysis reveals that 65% to 75% household's intake is lower than 2000 calories per capita per day. Village wise variation in calories intake by individual household also reflects the sample pattern. In all the sampled villages, half of

the surveyed households get less than 2000 calories per capita per day. It means that considerable sizes of rural population of the study-area are undernourished. The study shows that those engaged in services along with support of agriculture get better nutrition than the persons working as cultivators and laborers. It is very well highlighted that 259 households with mixed type of houses get less than 2000 calories per day. The results displayed that there is some association between nutritional status and type of houses. The data collected in this study reflects that more than 50% of the interviewed persons have less than 2000 calories per day. Thus, the incidence of

nutritional deficiency diseases varies from one development block to another upon their socio-economic conditions.

During the nutritional deficiency and disease, proper utilization of the existing health services provided by the health department facilities are very important, which probably depends on reliability, medical awareness, and motivation and finally on the perception of the people about the services and the need about a particular service. There is need for formal education and training at all levels. The improvement in the education systems in the study area will enhance the utilization pattern of healthcare facilities and increase the awareness about the nutrition and deficiency disease. Efforts are needed to increase diet quality and education for rural people so that they rise in economic status and are better sustained. Consistent valuation of nutritional status is needed for identifying nutritional issues and at-risk groups in a given population for the development of dietary interference programs and for monitoring the competence of such intrusions.

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