THE EVOLUTION OF URBAN GREEN SPACES (UGS). CASE STUDY: SOUTH-WEST OLTENIA REGION

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Abstract. Urban green spaces are a necessity in the innovative-sustainable and modern development of municipalities/cities, as they must ensure the reduction of the negative effects of climate change and atmospheric pollution on the environment, but at the same time, the supply of ecosystem services for resident urban communities must be ensured. The urban green space information of the Oltenia Region from 1960 and 2020 was used as basic statistical data for the study. The spatiotemporal characteristics of UGS changes in urban localities in the SW Oltenia region were analysed using the urban green space index; at the same time, the areas of green space (ha) were compared, in order to capture the evolution of UGS in the five counties of the region.

Keywords: urban green spaces, region, surface, population, Urban Green Space Index.

Rezumat. Evoluția spațiilor verzi urbane (UGS-uri). Studiu de caz: Regiunea Sud-Vest Oltenia. Spațiile verzi urbane sunt o necesitate în dezvoltarea inovativ-durabilă și modernă a municipiilor/orașelor, acestea trebuie să asigure diminuarea efectelor negative ale schimbărilor climatice și ale poluării atmosferice mediului ambiant, dar în același timp se impune asigurarea furnizării de servicii ecosistemice către comunitățile urbane rezidente. Informațiile spațiilor verzi urbane ale Regiunii Oltenia din 1960 și 2020 au fost utilizate ca date statistice de bază ale studiului. Caracteristicile spațio-temporale ale schimbărilor UGS din localitățile urbane din regiunea SV Oltenia, au fost analizate folosind indicele spațiului verde urban; totodată, au fost comparate suprafețele spațiului verde (ha), pentru evoluția UGS în cele cinci județe ale regiunii.

Cuvinte cheie: spații verzi urbane, regiune, suprafață, populație, Indicele Spațiului Verde Urban.

INTRODUCTION

The urban green space (UGS) is "the green lung of cities and usually performs important functions such as absorbing pollutants and rainwater and mitigating urban heat" (POUYA & AGHLMAND, 2022). They are absolutely necessary for the expansion and development of natural elements in urban spaces (LIU et al., 2022).

The UGS supports the natural environment structure, representing the only spatial entity with a natural biological activity and regeneration mechanism in the urban ecosystem of a region (ZOU & WANG, 2021). The increase in population in urban areas will necessarily lead to the continuous expansion of urbanized areas throughout the development region.

Half of humanity lives in urban areas worldwide (2 billion people) and, by 2050, it is estimated that this will increase to nearly 7 billion people living in urban areas (***. UN.DESA, 2019). The expansion of urban areas is the main cause for the reduction of green urban space (NOR et al., 2017), and the result of this expansion is the transformation of green spaces into construction land (WU et al., 2019).

The urbanization process had negative results: the natural environment degradation and the loss of global biodiversity (SETO et al., 2012), so the dynamics of green urban spaces has become an extremely important topic in the sustainable development of urban areas (WU et al., 2019).

Currently, the health crisis associated with the SARS-CoV-2 virus has further highlighted the need for green spaces in people's lives and the importance of their ecosystem services (KABISCH et al., 2021). Parks in particular (for example, the Youth Park is a hub in Bucharest's green infrastructure network), as areas that host numerous artistic and relaxation activities (STOIA et al., 2022), are spaces of great importance for urban populations (FAN & LUO, 2021).

The UGS can contribute to environmental benefits, such as the provision of ecosystem services (GAVRILIDIS et al., 2019; 2020): conserving the biodiversity of parks and gardens in the urban environment and regulating the climate, but also to economic profitability (WEY et al., 2022) of a certain area – for example, the urban pole centre of regional development in Oltenia, Craiova Municipality.

The need to seek refuge in nature has become a reality for more and more people who want to escape the stress of everyday activities. The beauty of nature, the landscape's panorama, the architecture of buildings and parks, and the harmony of lines, shapes, spaces and colours have a great influence on the human psyche and the general state of human health (GREEN et al., 2004, quoted by BEREȘ & VOICULESCU, 2005, VÎLCEA et al., 2014).

In Romania, the reduction in the surface of UGSs as a result of the accelerated process of private land retrocession and the informal aspect of urban planning have become quite normal (IOJĂ, 2009, quoted by BADIU, 2019, p. 43), which is also due a weak legislative framework and its frequent changes, in accordance with the interests of the responsible authorities (ONOSE et al., 2023).

Considering this and in accordance with GEO no. 195/2005 on environmental protection, Romania had to ensure by 2015, a value of 26 m^2 of urban green space per inhabitant, in all cities, regardless of their characteristics (BADIU et al., 2016; BADIU, 2019, p. 43).

The importance of the quantitative evaluation of urban green infrastructures in Romanian cities is also supported by the lack of information regarding the size, structure and determining factors in the definition of urban green spaces. Even though the obligation to create local registers of green spaces for each city has been stipulated in the national legislation since 2007, they have only been completed in 23% of the cities. Also, because the methodology for evaluating urban green spaces in Romania is not clarified, targets are difficult to monitor in this context (BADIU, 2019, p. 44).

On account of the reduction of UGS in our country, by means of Government Emergency Ordinance (GEO) no. 114/2007 for the amendment and completion of GEO no. 195/2005 regarding the protection of the environment, local public administration authorities have the obligation "to ensure an area of green space of at least 20 m^2/inh., until December 31, 2010, and of at least 26 m^2/inh., until 31 December 2013" (art. II, paragraph 1).

Structural elements of green spaces can be defined by the shape, surface or distribution of vegetation that make them up (LANCASTER & REES, 1979; KONG & NAKAGOSHI, 2006; MORGAN GROVE et al., 2006; BADIU, 2019, p. 30). Also, the shape and size of UGS amplify or diminish the impact that vicinity elements have on them (BADIU, 2019, p. 30).

Linear elements, such as street alignments or corridors located along the hydrographic network (ARRIF et al., 2011), will present a more pronounced border effect, compared to a park where the distance from the periphery to the central point is greater (PRIMACK et al., 2008; BADIU, 2019, p. 30.; VÎLCEA & ȘOȘEA, 2020).

Current approaches emphasize the importance of public accessibility, in the context in which the urban green space can address physical, psychological and financial barriers (GRĂDINARU et al., 2023). The sustainable management of green urban spaces is very important in the context of the need for green space per capita. UGSs may be managed privately (gardens of individual residential spaces), publicly (urban parks, street alignments) or semi-publicly (gardens of institutions or schools) (CVEJIĆ et al., 2015; BADIU, 2019, p. 22).

DATA & METHODS

Field of study. The South-West Oltenia Region is made up of five counties: Dolj, Olt, Gorj, Vâlcea and Mehedinți. The region has 28 urban localities – five are county seat municipalities – Craiova, Slatina, Râmnicu Vâlcea, Târgu Jiu and Drobeta Turnu-Severin, and 23 towns (Fig. 1).

The climate of Oltenia is temperate continental with sub-Mediterranean influences, especially in the south-western and western half, and continental influences in the eastern and south-eastern half (MARINICĂ & MARINICĂ, 2016).

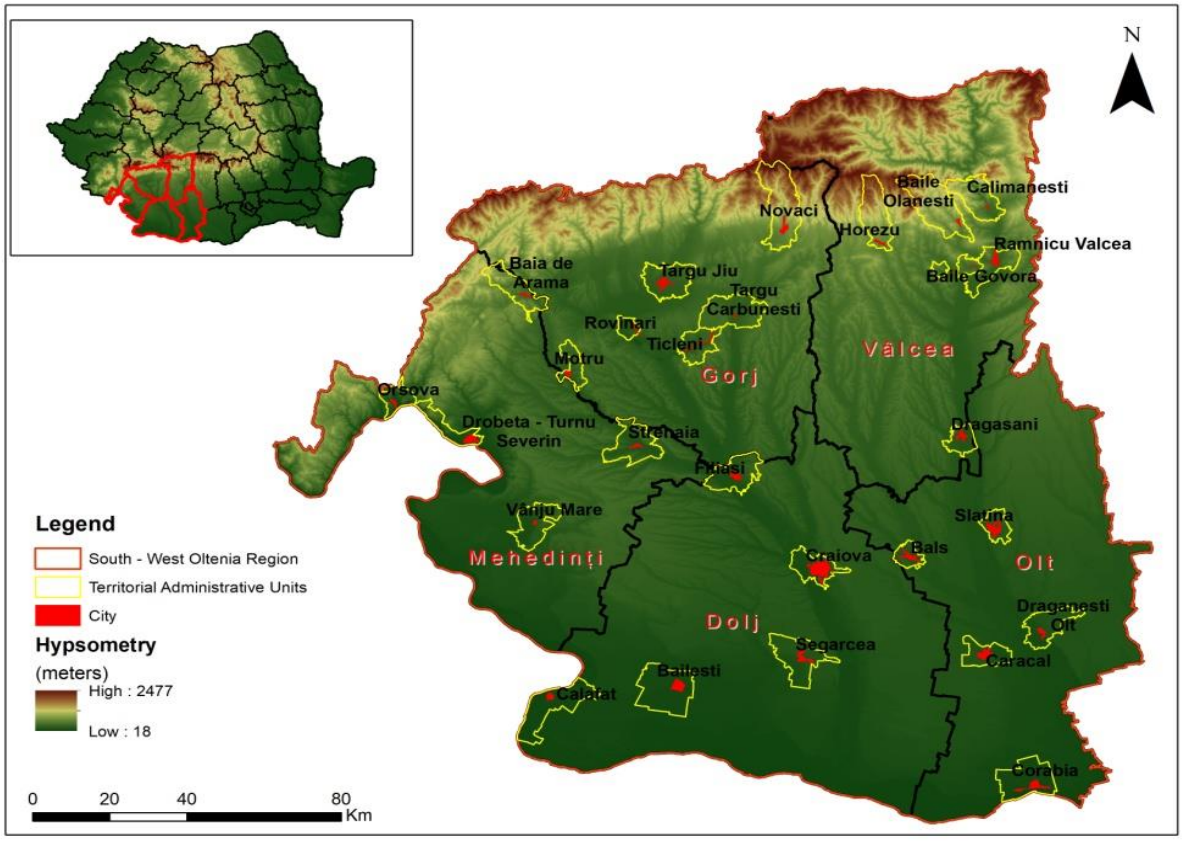

Figure 1. The location of Oltenia within Romania and of cities in the South-West Oltenia Region.
Source: authors' processing of data http://www.geo-spatial.org/

Methods and gathering of statistical data. For the 21st century, the geographic information system (GIS) represents a tool for investigating and evaluating the spatiotemporal dynamics of changes in the urban green spaces within a territory (example: South-West Oltenia Region).

For the achievement of the study area, we used the development of the spatial database, which was made using the ArcGIS 10.1 software tool, as well as the Excel spreadsheet software, part of the Office package, for calculating the Urban Green Space Index. The software (ArcGIS) has functions that allow for an analysis of the raster and/or vector data sets.

In order to create the map of green spaces at the level of the analysed unit, we downloaded the data from the website https://land.copernicus.eu/local/urban-atlas, for the year 2018.

To carry out this study, we used statistical data at the level of urban administrative-territorial unit, taken from the National Institute of Statistics of Romania, e.g. the data series from TEMPO online database. The data refers to the surface of green spaces at regional level (2020), green spaces at local level (2020), surface of green space in the county seat (1960-2020 expressed in ha) and, last but not least, the number of inhabitants in the county seat (1 July 2020).

Calculation of the Urban Green Space Index (DINDA et al., 2021;
https://insse.ro/cms/files/site_podca/actualizari/manual_preview%208.pdf)

$$I_{UGS} = {}^{S_{UGS}}/_{P_{total}} \text{ where,}$$

I_{UGS} – Green Urban Space Index
S_{UGS} – Surface of the green space urban in the county seat (ha)
P_{total} – Number of residents in the county seat - 1 July 2020

The UGS analysis, by calculating the urban green space index, highlights the areas with a low/high green space; this indicator is important in order to improve the health and well-being of the residents of the analysed cities.

By calculating the I_{UGS} we aimed to show which cities reach the European Union standards (26m^2/inh.), but also the standards of the World Health Organization - the ideal UGS should be 50 m^2 (POUYA & AGHLMAND, 2022) and a minimum of 9 m^2 of green space per person (SHEKHAR & ARYAL, 2019). Another objective of this study was to assess the evolution of the UGS surface over the last 60 years.

In conclusion, the purpose of the research was to evaluate the UGS index per capita and to investigate its distribution in the territory, by using the GIS software.

RESULTS & DISCUSSIONS

Evolution of the UGS surface in South-West Oltenia Region. In the South-West Oltenia Development Region, green spaces occupy an area of 2,799 ha, representing 10% of the national total of this category of land in 2020 (Fig. 2).

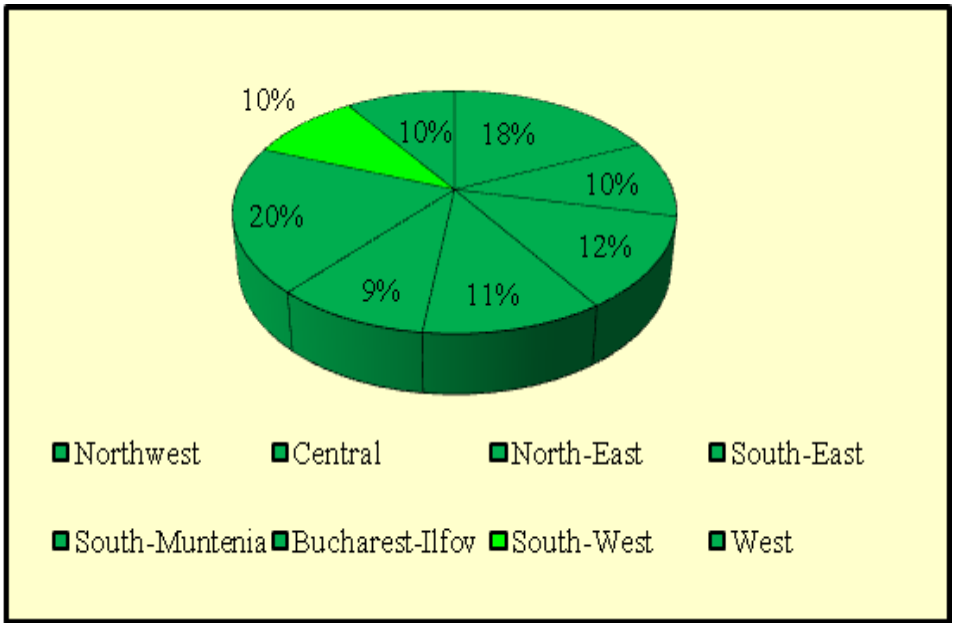

Figure 2. Percentage distribution of green spaces by development regions
Source: authors' processing of data insse.ro, 2022.

Analysing (Fig. 3) the geospatial data from Copernicus, for the year 2018, it is found that the urban area of Slatina Municipality has the largest part of green spaces in the central area, compared to the other county seat localities where the urban green spaces are dispersed in the territory from the centre to the peripheral areas.

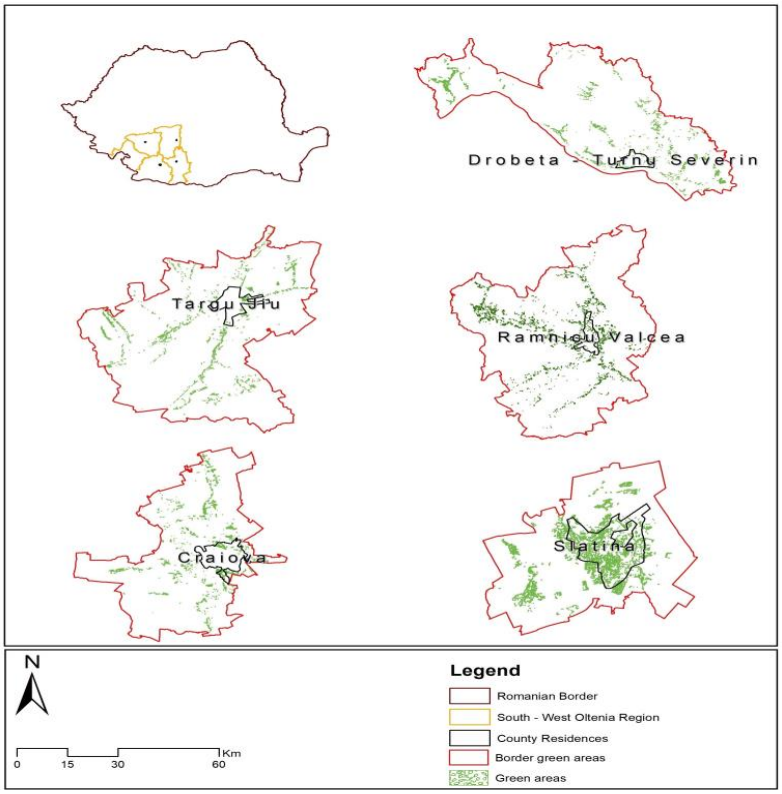

Figure 3. Green Urban Spaces 2018; Source: data https://land.copernicus.eu/local/urban-atlas.

As for the surface and share of green spaces in the territory, Dolj County stands out (Fig. 4), since 45% of the green spaces area in Oltenia is concentrated in Dolj County. At the opposite pole, we find the Gorj County with only 5% of the green spaces area in the region, which represents the lowest area of green space in the southwest part of Romania.

Current remote sensing programs, for example Copernicus (HARRIS & BAUMANN, 2015) and Landsat (ZHU et al., 2019) not only provide historical data in time and space, but also facilitate access to recently acquired data (SHAHTAHMASSEBI et al., 2021).

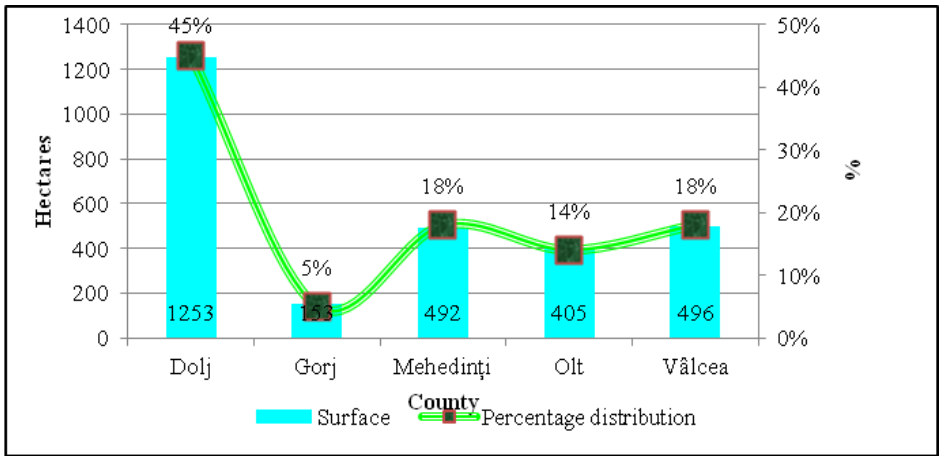

Figure 4. The area/share of green space per county 2020; Source: authors' processing data insse.ro, 2022.

The retrospective analysis of the green urban space surface within the municipalities and towns of South-West Oltenia Development Region, for the period 1960-2020, allows us to state that the arrangement of green spaces in the context of measures to improve living conditions has increased considerably year after year (Figs. 5 a, b, c, d, e).

According to statistical data during 1960-1965, in the Gorj County (Fig. 5a), Târgu Jiu Municipality recorded a surface of green space of 76 ha; also, in the same period, Motru, Târgu Cărbunești, Novaci, Țicleni and Rovinari did not register a single hectare of green space.

At the regional level, the largest area of UGS was registered by the Municipality of Craiova (Fig. 5b). In the period 2015-2020, the city had a total surface of 1,040 ha, compared to 1960, when it only had an area of 64 ha. The increase was determined by the expansion, the development, and the modernization of UGS (i.e. Nicolae Romanescu Park, Tineretului Park, English Park, Lunca Jiului Park, National Theatre Park, Botanical Garden, Buzești Brothers Garden). The Nicolae Romanescu Park is located in the southern part of Craiova, being one of the most valuable monuments of landscape architecture in the country (FIRAN & FIRESCU, 1982, p. 129); it represents the largest area of UGS.

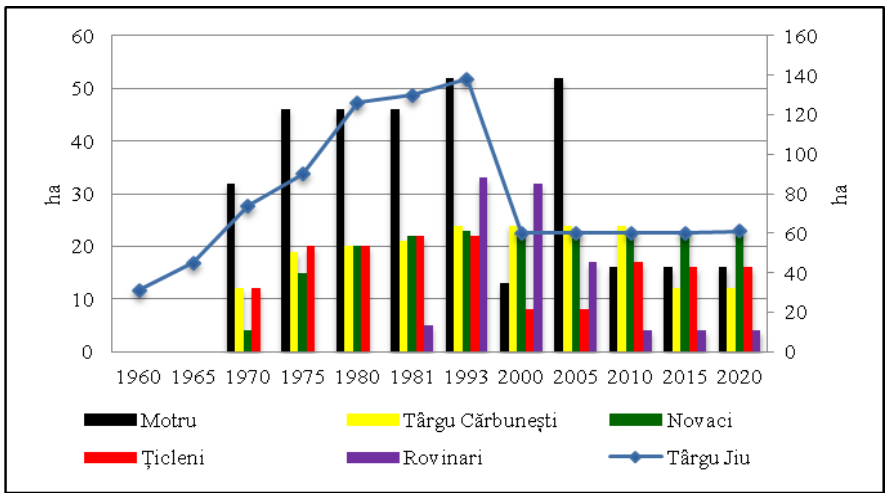

Figure 5a. Evolution of UGS in Gorj County; Source: authors' processing data MUJA, 1984; insse.ro, 2022.

The special value of this park is shown by the extremely large number of specimens of trees and ornamental shrubs, brought from several continents and acclimatized to the latitude of the Municipality of Craiova, some of which are extremely rare in Romania (COCEAN et al., 2011, p. 27): *Taxodium distichum* – pond cypress (originally from North America), *Pinus excelsa* – Himalayan pine, *Abies pinsapo* – Spanish fir, *Corylus colurna* – Turkish hazel, *Alnus glutinosa laciniata* – alder with very finely divided leaves, *Fague moesiaca* – Balkan beech, *Quercus robus* – pediculate oak, *Quercus borealis* (*Q. rubra*) – red oak, *Celtis occidentalis* – heartwood of North American origin, *Junglas nigra* – black walnut, *Platanus hybrida* – plane tree, *Sophora japonica* – Japanese acacia, *Acer saccharinum* – sweet maple, *Ptelea trifoliata* – North American tree, *Aesculus carnea* – hybrid red chestnut.

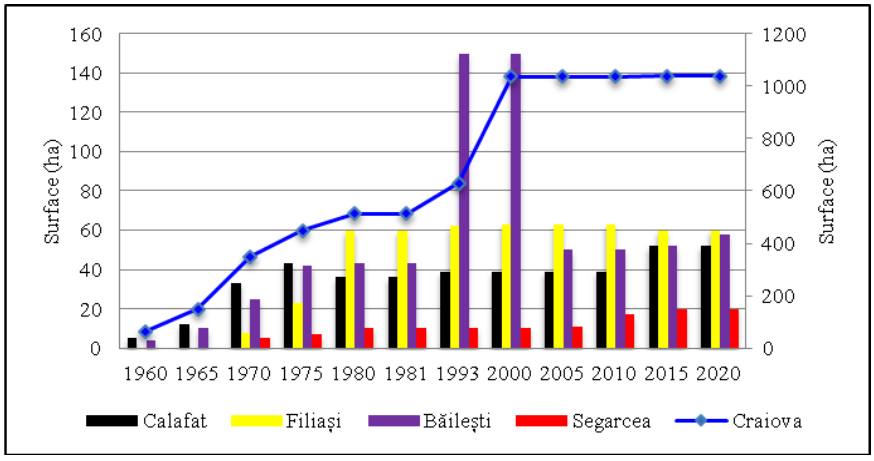

Figure 5b. Evolution of UGS in Dolj County; Source: authors' processing data MUJA, 1984; insse.ro, 2022.

Drobeta Turnu Severin, the capital of the Mehedinți County (Fig. 5c), registered an increase in green space of 185 ha from 1960 to 2000, compared to the other four towns where the smallest areas were registered. Thus, a strategy for increasing and developing the urban green space is required in Orșova, Strehaia, Baia de Aramă and Vânju Mare. For example, any land outside the built-up area can be transformed into urban space, resulting in the development of new urban green spaces (i.e. increasing the index of urban green space/capita).

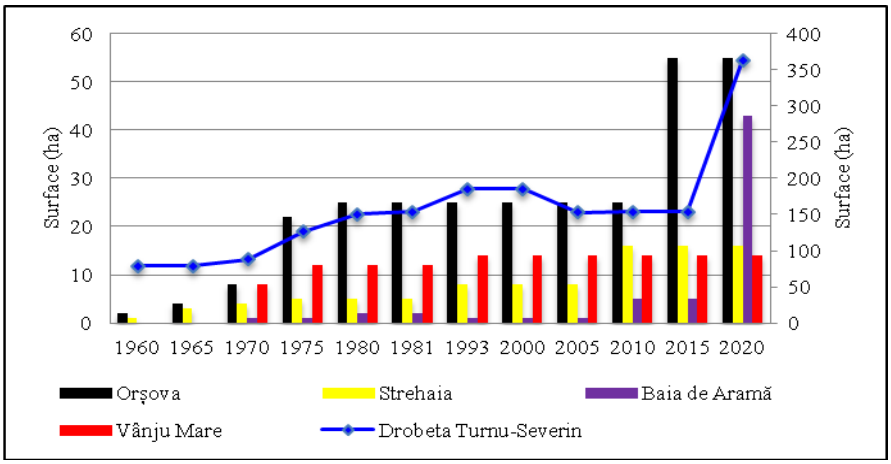

Figure 5c. Evolution of UGS in Mehedinți County; Source: authors' processing data MUJA, 1984; insse.ro, 2022.

In the case of the Olt County, Slatina recorded an upward trend from 1965 to 1981, followed by a slight decrease from 2000 to 2020 (Fig. 5d). Also, there is an obvious growth in green space during 1970-1993 in Drăgănești-Olt.

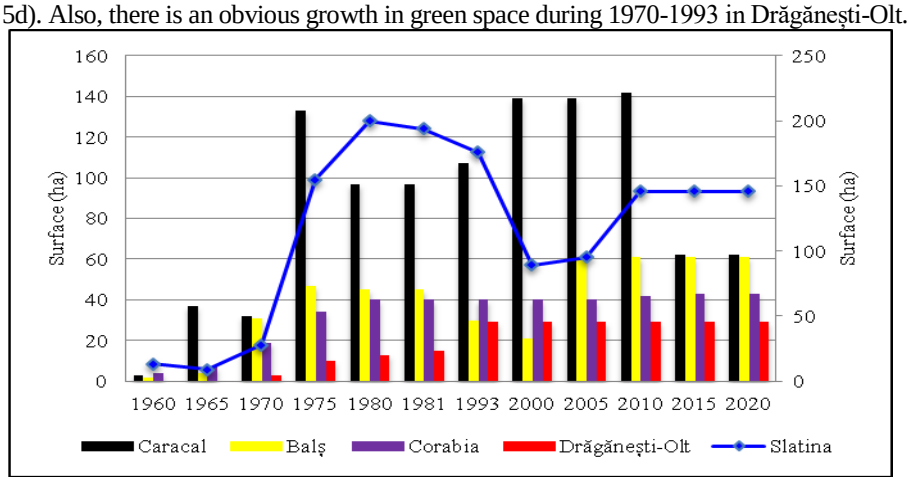

Figure 5d. Evolution of UGS in Olt County; Source: authors' processing data MUJA, 1984; insse.ro, 2022.

For the Vâlcea County, seven towns were analysed (Fig. 5e), with theRâmnicu-Vâlcea Municipality recording a maximum value in 1993 (350 ha); at the opposite pole, the lowest surface was recorded in Ocnele Mari. The decrease in the area of UGS after year 2000 is due to the increase in surfaces used for the construction of blocks, i.e. urban land surfaces were automatically transformed into building spaces (outside built-up area). From our point of view, these decreases cause health problems for the population and, at the same time, a discomfort caused by the lack of spaces designed specifically for rest and recreation.

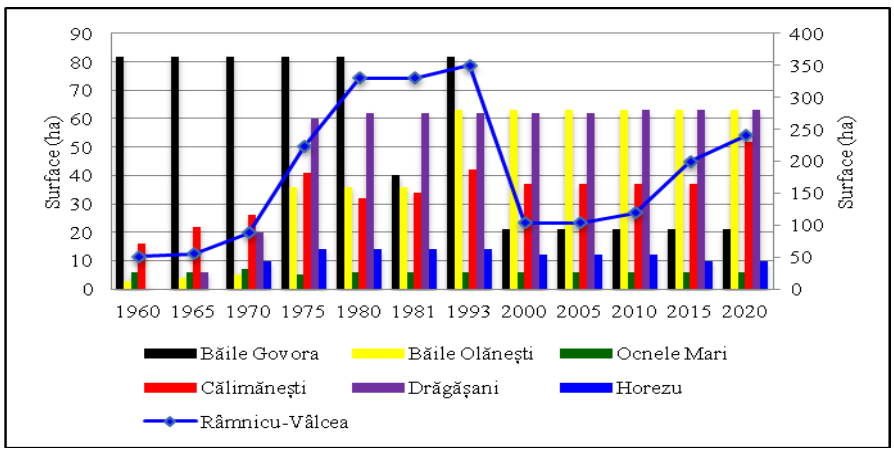

Figure 5e. Evolution of UGS in Vâlcea County; Source: authors' processing data MUJA, 1984; insse.ro, 2022.

Based on the data analysed for the year 2020, the green space surface in the county seat (ha) was assessed for each of the five counties. Thus, the first place belongs to Băile Olănești with 141.66 m^2/inh., followed by Băile Govora with 78.68 m^2/ inh., followed by Baia de Aramă in the third place with 77.85 m^2/ inh. The last two places were occupied by the Municipality of Târgu Jiu with 6.45 m^2/ inh. and Rovinari, with a value of 3.04 m^2/ inh. (Fig. 6 and Table 1).

The following towns registered values above the regional average (33.44 m^2/ inh.): Craiova (34.77 m^2/inh.), Drobeta-Turnu Severin (34.57 m^2/inh.), Țicleni (34.95 m^2/inh.), Novaci (40.96 m^2/inh.), Orșova (45.30 m^2/inh.), Călimănesti (59.59 m^2/inh.), Baia de Aramă (77.85 m^2/inh.), Băile Govora (78.68 m^2/inh.), and Băile Olănești, which recorded the highest value, namely 141.66 m^2/inh.

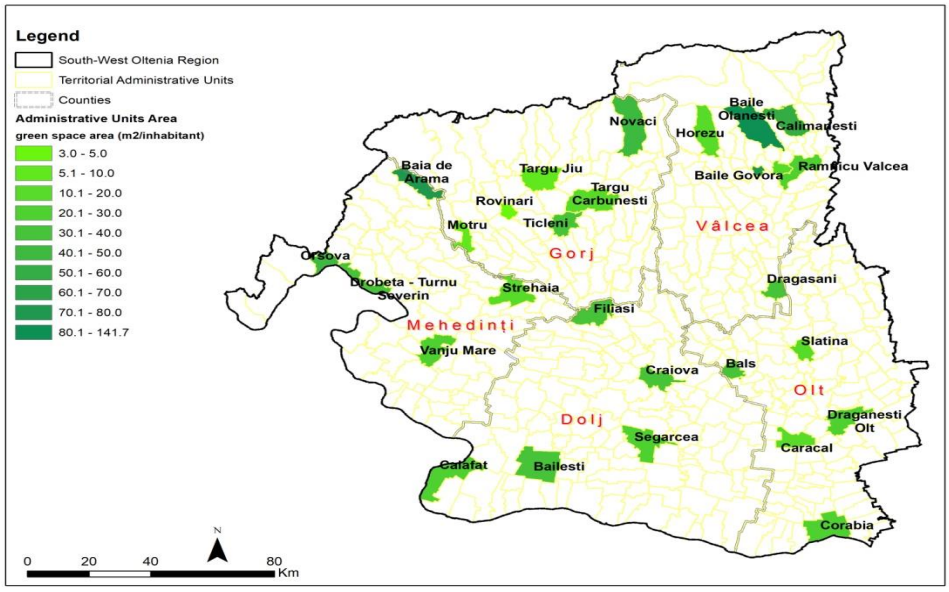

Figure 6. Green Urban Space Index in 2020; Source: authors' own processing in the GIS software.

Table 1. Green Space Indicators for South-West Oltenia Development Region Urban Environment (2020).

Crt. no.	County	Urban settlements	Inhabitants (July 1, 2020)	Total surface of GUS (ha)	GS/inh. (m^2/inh.)
1.	Dolj	Craiova	298,952	1040	34.77
2.	Dolj	Calafat	17,574	52	29.58
3.	Dolj	Filiași	18,025	60	33.28
4.	Dolj	Băilești	19,294	58	30.06
5.	Dolj	Segarcea	7,912	20	25.27
6.	Gorj	Târgu Jiu	94,441	61	6.45
7.	Gorj	Motru	21,364	16	7.48
8.	Gorj	Târgu Cărbunești	8,569	12	14.00
9.	Gorj	Novaci	5,614	23	40.96
10.	Gorj	Țicleni	4,577	16	34.95
11.	Gorj	Rovinari	13,115	4	3.04
12.	Mehedinți	Drobeta-Turnu Severin	105,266	364	34.57
13.	Mehedinți	Orșova	12,140	55	45.30
14.	Mehedinți	Strehaia	10,978	16	14.57
15.	Mehedinți	Baia de Aramă	5,523	43	77.85
16.	Mehedinți	Vânju Mare	5,828	14	24.02
17.	Olt	Slatina	82,230	146	17.75
18.	Olt	Caracal	33,601	62	18.45
19.	Olt	Balș	20,298	61	30.05
20.	Olt	Corabia	17,024	43	25.25
21.	Olt	Drăgănești-Olt	11,646	29	24.90
22.	Vâlcea	Râmnicu Vâlcea	117,214	240	20.47
23.	Vâlcea	Băile Govora	2,669	21	78.68
24.	Vâlcea	Băile Olănești	4,447	63	141.66
25.	Vâlcea	Ocnele Mari	3,452	6	17.38
26.	Vâlcea	Călimănești	8,726	52	59.59
27.	Vâlcea	Drăgășani	20,028	63	31.45
28.	Vâlcea	Horezu	6,865	10	14.56

Source: processing data insse.ro, own calculations

Benefits of urban green spaces. UGSs, such as parks, provide an important place for people to be active (MACINTYRE et al., 2008): the Nicolae Romanescu Park and Tineretului Park in the Municipality of Craiova, botanical gardens, gardens surrounding blocks, all of them provide a series of potential benefits to the residents of Oltenia. Thus, the accessibility of UGs for the population positively influences the performance of physical activities, but also their frequency (COOMBES et al., 2010).

The exposure, the use and the visitation of UGSs can significantly improve the physical and mental health of the population, through physical exercise, social interaction, recreation and rest (KACZYNSKI & HENDERSON, 2007; ARTMANN et al., 2017) for urban residents (MARINESCU & CURCAN, 2021), simultaneously decreasing the levels of anxiety and stress (TYRVÄINEN et al., 2014; COX et al., 2017; HAZER et al., 2018; LI et al., 2018), to which we can also add the optimization of the state of mind and respiratory conditions.

UGSs can represent real opportunities for society, as individuals come into direct contact with the natural environment (LEE et al., 2015). Such direct contact has positive restorative effects on mental health and well-being and may actually help to provide a barrier against unpleasant/stressful events in one's life (NILSSON et al., 2011; VAN DEN BERG et al., 2010).

These benefits for physical and mental health can become even more critical in times of crisis (VAN DEN BERG et al., 2010), for example: the economic crisis of 2008-2010 and the economic crisis caused by the new virus (SARS-CoV-2) (SAMUELSSON et al., 2020; MCCUNN, 2021; DRĂGULEASA & MAZILU, 2022; MAZILU et al., 2023), as residents face increased stress related to economy, health, sadness, isolation, but also to limited mobility during implementation of social distancing policies and laws (BROOKS et al., 2020).

Even so, the use of urban green spaces during the Covid-19 pandemic may be limited by people's lack of access to UGSs, in addition to the temporary closure of parks and facilities (LOPEZ et al., 2021) and activities related to some destinations' overcrowding (DRĂGULEASA et al., 2023). This presents a unique challenge for governments and town institutions to decide how to safely and rationally manage UGSs during an economic or health crisis (LOPEZ et al., 2021).

CONCLUSIONS

The green urban spaces within the South-West Oltenia Development Region are relevant for the process of urban planning, territorial-administrative planning and geographical space organization. In accordance with what has been listed previously, in order to determine the areas with a deficit of green urban space from a functional point of view, information is needed regarding the form, distribution, and categories of green space to be created for an environment that satisfies the population need to relax in an unpolluted space and a healthy living environment.

Also, for a sustainable preservation of biodiversity, urban spaces are a generator of new habitats for plant and animal species and, last but not least, they represent a balance between natural areas (forest ecosystems) and urban space or peripheral areas that are to be developed from an economic point of view.

In the South-West Oltenia Development Region, green spaces are holding a surface of 2,799 ha, the occupied percentage representing 10% of the national total of this category of land.

The approach proposed in this paper for the analysis of the time evolution of the area of urban green spaces depends on the availability and collection of data sets: the area of urban green space (ha) and the population of the 28 towns.

The analysis of the index of urban green space per capita showed that three towns (Târgu Jiu, Motru and Rovinari) out of 28 do not have the minimum green space per capita recommended by the WHO for a healthy life; thus, all the other obtained values (25 towns) have a UGS index above the WHO minimum value.

In conclusion, according to the recommended European average of 26 m^2/inh., in 2020, it can be seen that two municipalities (Craiova and Drobeta-Turnu Severin) and 12 towns (Calafat, Băilești, Filiași, Balș, Dragășani, Țicleni, Novaci, Orșova, Călimănești, Baia de Aramă, Băile Govora and Băile Olănești) have exceeded this recommendation. Thus, after calculating the green urban spaces index, it was found that the towns of the Vâlcea County have the highest values.

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CONFLICTS OF INTEREST

The authors declare no potential conflict of interest concerning the research.

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