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# Challenges of urban expansion in the Skopje region.

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## Summary

Urban expansion in North Macedonia is a multifaceted process, largely influenced by policies integrated into national legislation as part of the European integration agenda. The decentralization process implemented between 2004 and 2007, along with the Law for local self-government from 2002, empowered municipalities to make and execute decisions at the local level, including those related to spatial and urban planning. This expansion is evident in the regional dispersal of built structures across North Macedonia.

This paper focuses on a particular aspect of urban expansion: the tendency for development to occur outside of established planning restrictions. This phenomenon often results in the emergence of urban agglomerations that encroach upon administrative boundaries. To analyse this trend, data from geographic information systems (GIS), obtained from the Corine Land Cover and Microsoft Building Footprints programs, was utilized. This data was subjected to both cartographic and alphanumeric analysis to assess the extent and characteristics of urbanization in the Skopje region between 2003 and 2020.

The analysis specifically examines the situation in the first and second contact zones surrounding the city of Skopje, highlighting the scale and complexity of built structures that exist beyond the city's planned boundaries. Through this analysis, the paper aims to provide insights into the patterns and implications of urban expansion in North Macedonia, particularly in relation to the challenges posed by development occurring outside of established planning frameworks.

**Keywords:** urban expansion, regional observation, territorial governance, digital transitions, GIS

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## Introduction

The driving processes of urban expansion are the significant population growth and natural increase in developed countries, migration from urban areas and the transformation of rural areas into urban centers (Hegazy & Kaloop, 2015; Melchiorri, et al., 2018). This phenomenon entails the dynamic development of urban areas in peripheral urban and suburban zones, mainly at the expense of undeveloped agricultural land (Hennig, et al., 2016). This spatial repercussion can be defined as a polycentric mega-city region (Hall & Pain, 2006) which participates in the functions of the city and thus becomes an integral part of an extended urban complex.

In North Macedonia, the degree of suburbanization is recognizable through the uncontrolled dispersion of built facilities (Gorin, et al., 2022). Functional transformations in the country tend to occur in the peri-urban zone, between the urban and the rural areas. In this space, there are usually deviations from the planning directions for the arrangement of settlements and the area as a whole. According to the Draft Plan of the Spatial Plan of the Skopje Region for 2005-2020 (Spatial planning agency, 2010), the processes manifested in the immediate surroundings of the city indicate the degradation of the natural environment through the permanent conversion of quality agricultural land. The occurrence can be attributed to inadequate planning and land utilization in the peripheral zones, stemming from demographic concentration, the expansion of highway and regional infrastructure, and, more recently, the proliferation of economic facilities.

According to the annual report the annual reports on the implementation of the Spatial Plan of the Republic of Macedonia (Spatial planning agency, 2006-2019), the mutual spatial-physical connection of urban agglomerations and settlements in the suburban zone, especially present in the zone of influence of large and medium-sized urban settlements, takes the form of:

- continuous-linear built facilities along communication lines;
- radial expansion of built facilities and creation of compact built spaces with surrounding settlements.

Linear expansions and connections are intensive, especially along the highway infrastructure corridors, as well as along the regional routes. The most visible repercussion of this type of urbanisation is evident in the contact zones of the City of Skopje, mainly represented by the industrial development, and less so in the residential areas. The tendency of linear expansions is to detach from the city of Skopje and aggregate along the contact zone, especially in the immediate vicinity of existing roads.

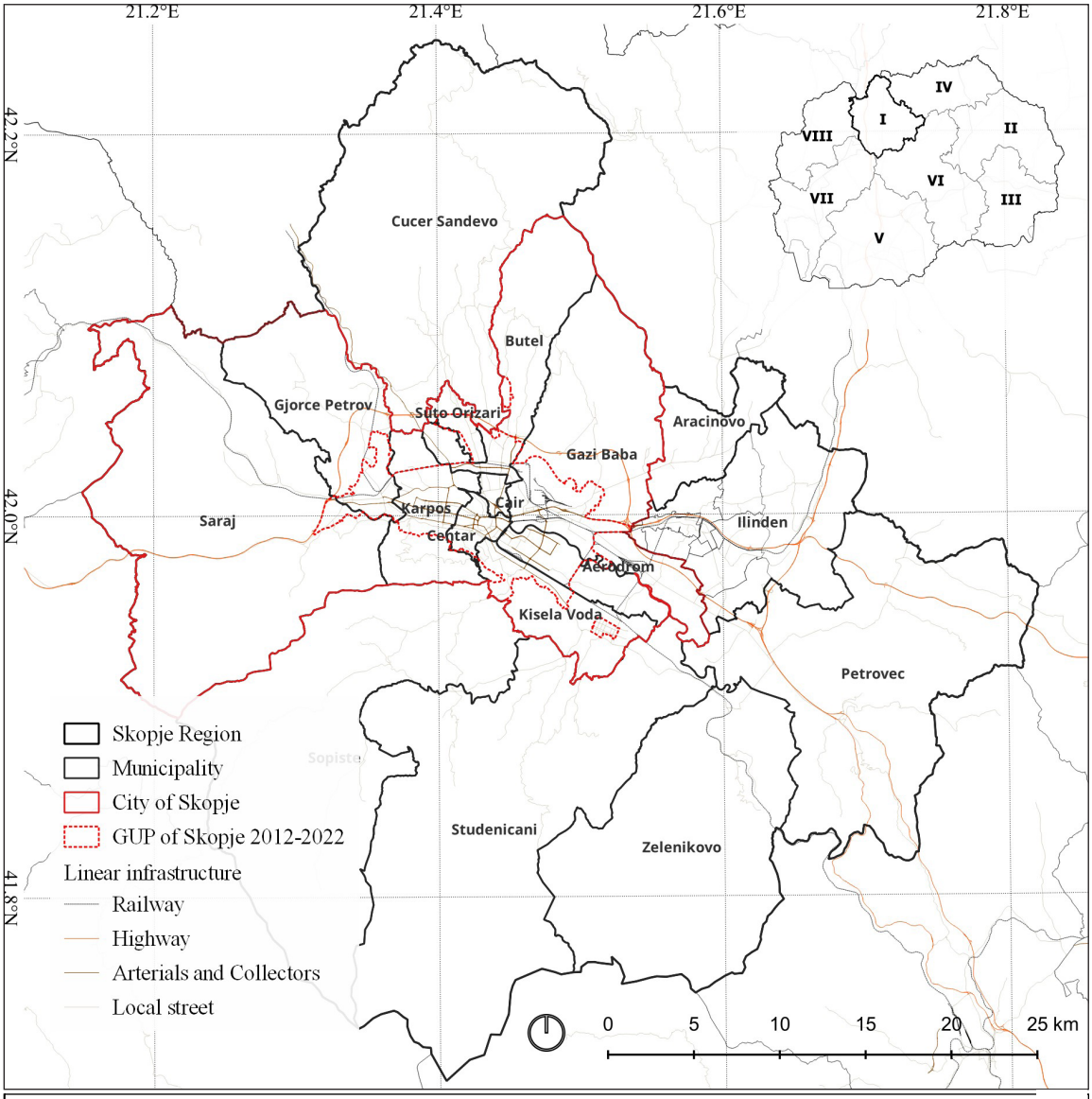
A further increase in urban expansion is expected, so consistent data on the degree of outreach are needed, especially with a view to allowing for comparisons across Europe. To that end, the timely detection of changes in land use (LU) and land coverage (LC) is crucial for understanding the interaction between built facilities and spatial repercussions (Cieślak, et al., 2020; Feranec, et al., 2010; Wiatkowska, et al., 2011). Hence, this paper highlights the importance of monitoring the current conditions of LC and LU in the context of urbanization processes, through the analysis of built content and surface facilities, based on geographic information system (GIS) processing of publicly available and internationally recognized datasets.

## Subject and objectives of the research

The total area of Skopje Region is 25,713 km$^2$ and, according to the last population census in 2021, there are 1,836,713 inhabitants living within its borders. The Skopje Planning Region occupies the northern part of the country and extends into the Skopje Valley. It is the smallest area (1,812 km$^2$) and covers only 7.3% of the total territory of the country. However, according to the data from 2021, it has the largest number of inhabitants (607,007 or 33% of the total population) and it is also the most densely populated region in the country, with 336 inhabitants per km$^2$. A high concentration of material and human resources contributes to the Skopje Planning Region having the largest share in GDP (43%) according to 2018 data from the State Statistics Office .

The city of Skopje, as a separate unit of local self-government, defined by the municipalities it includes, covers a total surface of 569.34 km$^2$, i.e. 31.5% of the entire Skopje Region. It is located in the central and western part of the Skopje Planning Region, and it is 22 km long and 11 km wide. In addition, it is regulated by the limits of the General Urban Plan (GUP) for the city of Skopje, which for the planning period 2012-2022 covers 87.9 km$^2$, i.e. 4.85% of the total area of the Skopje Region.

Figure 1. The administrative-territorial organization of the Skopje Region




| | (km²) | % |
|---|---|---|
| **Skopje Region** | 1,808.96 | 100.0% |
| Skopje Planning Region | | |
| **Municipality** | | |
| Municipalities in Skopje Region | | |
| **City of Skopje** | 569.34 | 31.5% |
| Municipality of the City of Skopje | | |
| **GUP Skopje** | 87.9 | 4.85% |
| General Urban Plan of the city of Skopje 2012 - 2022 | | |

I - Skopje, II - Eastern, III - Southeastern, IV - Northeastern, V - Pelagonia, VI - Vardar, VII - Southwestern, VIII – Polog Planning Region.

According to data from the 2021 census, the total number of inhabitants living in the municipalities within the borders of the City of Skopje is 526,502. Of these, 422,540 or 80.3% live in urban centers and 103,962 inhabitants or 19.7% populate rural areas. The rural population in the Skopje Region is distributed in such a way that 103,962 people live in so-called city municipalities, while 80,505

reside in municipalities based in villages. In the Skopje Region there are 145 villages and the city of Skopje is home to 607,007 inhabitants as per 2021 census data. Of these, 184,467 or 30.4% live in the rural environment (rural population), and 422,540 inhabitants or 69.6% reside in the urban environment (urban population), determined by the boundaries of the GUP of the city of Skopje (Markoski & Dimitrov, 2022).

Comparing the population data from the last two census cycles (2002 and 2021), a slight positive growth index can be observed at the level of the Skopje Region and the city of Skopje. In 2021, the latter recorded 19,576 inhabitants more than in 2002, which represents an increase of 3.9% in the number of the population. The former saw a population increase of 5% or 28,863 additional inhabitants.

Despite ongoing work tracking and supplementing the National Infrastructure for Spatial Data (NIPP), the information collected seems to be still dependent on inert synchronisation of multi-sector communication and cooperation. As such, planning processes continue to rely on data that do not give the real picture of the situation on the ground and do not guarantee the principles of sustainable development.

The national spatial and urban planning procedures and processes are legislatively and statistically recorded by –the European Spatial Planning Observatory Network (ESPON) – Study Programme on European Spatial Planning, 2018. The experts involved in this study assess that the Macedonian planning system is relatively rigid and centralised given that municipalities lack resources to undertake comprehensive planning procedures (ESPON / COMPASS, 2018). Considering that the time horizons of the main planning documents, such as the "Spatial Plan of the Republic of Macedonia 2002-2020" and the "General Plan of the City of Skopje 2012-2022" have expired, and that new ones have been initiated, it is important for future planning processes to unify spatial information with the latest/state-of-the-art data from the national, regional and local level.

To that end, this research broadens the scope of the investigation of local dynamics to the entire geographical area of Skopje Region and aims to detect and analyse the built facilities and urban agglomerations in the region by combining global datasets and publicly available information. It then delves into two distinct case studies, one representative of each of the primary and secondary contact zones within the planning boundaries of the city of Skopje. These cases, identified through comprehensive research, exhibit the most notable instances of urban expansion over the past two decades.

## Methods and sources

The research method used includes a linear work process and obtains/generates/collects information by processing geospatial data sets for remote sensing of land coverage changes; data resources for detection and analysis of built facilities; planning documentation at national and local levels, and satellite data. The selected sources are processed using the geographic information system software Quantum GIS (QGIS), a software for geo-referenced cartography. The ensuing results are mapped and tabulated.

## Geospatial datasets for remote sensing and LULC classification

The analysis of LU and LC changes is based on data from existing geospatial datasets, classified and developed by long-term Earth observation missions, like Corine Land Cover (CLC). The CLC Copernicus programme of the European Space Agency (ESA) relies on Collecte Localisation Satellites (CLS) to issue digital maps generated mainly from classification of satellite images. The same programme also developed the Urban Atlas product[1], which uses high-resolution satellite data to produce digital LU and LC maps of Functional Urban Areas (FUA)[2] for the most populated cities in Europe. In 2018, the nomenclature of this product included 17 urban subcategories and 10 rural subcategories. Four hierarchical levels are defined in the nomenclature for artificial areas (thematic group 1), and two others for agricultural areas (thematic group 2-5). Given that this product is used for the analysis of LU and LC in urban areas (2020), it becomes useful also for the purpose of this paper.

## Data sources for detection and analysis of built-up area

Built facilities are a basic generative element of urban expansion and are analysed through GIS data processing. Two additional sources are used to upgrade the database for this procedure, namely:

1. BingMapsAI - Microsoft Building Footprints
    a. Retrieved on 15.October.2022

b. Parts: 00051; 00179/

2. OSSP - Distribution Portal of the Real Estate Cadastre Agency
   a. Order made on 01.November.2022
   b. Sheet number: 682 – 3 – 3 ; 682 – 3 – 4; 732 – 1 – 1; 732 – 1 – 2/

The data is instantly transformed into tabular documentation through the processing of the cartographic material, in which the necessary features are generated for each built object, such as surface, region, purpose etc. The database aggregates in a single GIS model 129,000 built

Table 1. Fragment of summary data

| id [1] | latitude and longitude [2] | source [3] | program [4] | region [5] | surface m²[6] |
|---|---|---|---|---|---|
| | | | | | |
| 1 | 41° 58'29.88", 21° 13'58.42" | BingMapsAI | 11240 | 1st contact zone | 42.9 |
| 2 | 41° 58'30.53", 21° 14'5.194" | BingMapsAI | 11240 | 1st contact zone | 134.5 |
| 3 | 41° 58'25.71", 21° 14'2.549" | BingMapsAI | 11240 | 1st contact zone | 101.9 |
| ... | | | | | |
| 128998 | 41° 59'29.07", 21° 31'5.804" | OSSP | 12100 | 2nd contact zone | 729.4 |
| 128999 | 41° 59'21.55", 21° 30'1.287" | OSSP | 12100 | 2nd contact zone | 1421.7 |
| 129000 | 41° 58'27.60", 21° 14'4.855" | BingMapsAI | 11240 | GUP | 124.1 |

*Source: Authors' Contribution*

facilities for the territory of the Skopje region in 2022 (Table 1). Of these, 10.1% were taken from the Distribution Portal of the Real Estate Cadastre Agency, with a total built-up area of 2.5 km$^2$, while 89.9% were taken from Microsoft's programme for mapping with the help of artificial intelligence, with a total built-up area of 22.2 km$^2$.

## Planning documentation applied at national and local levels

The national spatial planning legislation is made up of the hierarchical order of planning documentation, starting from the spatial plan of the region, the general urban plan of Skopje (GUP) and the detailed urban plans.

Planning documents of the highest hierarchical order in the context of the Skopje Region, as a wider case study are:

- "Spatial plan of the Republic of Macedonia", planning period 2004-2020, and
- "Spatial plan of the Skopje region", planning period 2005-2020 and a draft plan issued on 23.02.2011.

The general urban plan of the city of Skopje (GUP), planning period 2012-2022, is the cardinal/key/ most important document.

Sectoral studies that precede the final version of the general urban plan look at the relationship between the general planning boundaries of the city of Skopje and its immediate surroundings. This research considers the following sectoral studies:

- Penev, P., 2011. City of Skopje with contact zones, General Urban Plan of the City of Skopje 2012-2022 [Градот Скопје со контактните зони, Генерален Урбанистички план на Град Скопје 2012-2022], Skopje: Spatial Planning Agency.

- Trpenoska-Simonovikj, L. & Lukikj, Korobar, A., 2022. Contact zone, General Urban Plan of the City of Skopje 2022-2032 [Контактна зона, Генерален урбанистички план на Град Скопје 2022-2032], Skopje: Spatial Planning Agency.

Prior to drawing its conclusions, the research zeros in two specific case studies, which represent a defined, predetermined territorial fragment of the first and second contact zones of the Skopje Region. The first case refers to the settlement of Vizbegovo, while the second to the agglomeration unit Ilinden 1 (their categorisation is explained in detail in section 3).

The settlement of Vizbegovo is administratively managed by the Municipality of Butel, which belongs to the category of urban municipalities, with its seat in the city. One urban-planning document was consulted here, covering the planning period 2019 to 2029. This detailed urban plan is being developed from 2014-2024, and

although still not adopted, it is the subject of analysis in this research, as it is the only planning document that we can consult.

The agglomeration unit Ilinden 1 is administratively managed by the Municipality of Ilinden, which belongs to the category of rural municipalities, based in a village. 16 urban-planning documents were consulted in this research, covering the planning period 2008 to 2018, and a different time frame was determined for each of the plans.

The collection of all these planning documents aims to synthesise and cartographically represent the direction of the plans and the zones chosen for future development; the purpose of the existing built content with their planning use class; as well as the intended purpose of the empty land not yet built.

## Satellite data

To chronologically analyze the morphological and programme conditions of the built facilities in the selected case studies from the first and second contact zones, a high-resolution orthophoto map is used as a basis for manual detection of built facilities. The historical position is determined using an orthophoto map for a period beginning with 2003. The material is taken from the online platform of Google Earth Pro and is geo-referenced in the appropriate research datasets:

1. Vizbegovo,
   a. Google Earth Pro V 7.3.6.9345 (May 20, 2003). Skopje region. Cadastral Municipality of Vizbegovo. 42O02'19.09"N, 21O24'15.67"E, Eye Alt 16640 ft. Landsat / Copernicus. Maxar Technologies 2023
2. Ilinden 1
   a. Google Earth Pro V 7.3.6.9345 (August 18, 2003). Skopje region. Municipality of Ilinden. 41O59'41.70"N, 21O37'03.79"E, Eye Alt 11625 ft. Landsat / Copernicus. Maxar Technologies 2023

Consequently, these are used as a basis for manual processing of the digitised vector polygons to detect the built structure in 2003 and compare with the current percentage.

## Results

The compiled database allows for a cartographic-tabular analysis that focuses on:

- the number of settlements and the population dynamics in the first and second contact zones;
- the purpose and percentage of built facilities in the first and second contact zones;
- two specific case studies (i.e. cadastral municipality of Vizbegovo and agglomeration unit Ilinden 1), their chronological tendencies and differences in the use class of the built facilities.

## Settlements and population dynamics in the first and second contact zones

The settlements of non-city municipalities are the subject of the sectoral studies during the preparation of the General Urban Plan of the City of Skopje (Penev, 2011; Trpenoska-Simonovikj & Lukikj Korobar, 2022). The sectoral studies were developed specifically for the contact zones and their relationship with the city. Two zones were defined: (1) individually recognized settlements in the immediate contact zone of the city and (2) agglomerations of suburban villages in the wider contact zone of the city of Skopje.

The first contact zone covers settlements that have intensive development along the roads, and which spread radially from the city to its surroundings. It consists of newly built settlements, which are not predominantly agrarian, and whose population is mostly engaged/active in the city of Skopje. A total of 61,333 inhabitants are located in this group of 20 settlements according to the 2021 census, representing 10.1% of the total population in the Skopje Region. The population in the first contact zone records a positive dynamic, reflected in 5,862 more inhabitants in 2021 compared to the 2002 census. This change represents a population growth of 15.6%.

The second contact zone of suburban villages includes settlements that are not physically connected to the urban agglomeration. They have their own residential independence and physiognomy but are in the immediate surroundings of the city. 57 settlements are classified in the group of suburban villages, which are grouped into 14 agglomeration units. According to the 2021 census, a total of 96,970 residents lived in the second contact zone, which represents 16% of the total population

in the Skopje region. Again, the dynamics of the population shows a positive tendency also in the second contact zone , with 12,794 more inhabitants in 2021 compared to the 2002 census.

This change marks a population growth of 15.2%. An additional number of 68 rural settlements are located in the peripheral zone of the Skopje Region. According to the 2021 census, 27,221 inhabitants live there, representing only 4.5% of the population of the region. The growth index in this category of settlements records a negative outcome, i.e. a reduction of the population by 2,065 inhabitants in 2021 compared to the 2002 census. Settlements of this type are located mainly in the hilly-mountainous and peripheral parts of the valley, and are mostly small in size.

## Programme features and percentage of built-up area in the first and second contact zones

The parameters for the programme and territorial affiliation, as well as the percentage of built content are obtained through a software procedure. An interactive link is created between the Microsoft Building Footprints database, with 2022 as reference period, and the layer of Urban Atlas product, with 2018 as reference period. Finally, the software generates the information about the built area in m2 or km² (aggregate).

The cartographic-tabular analysis in Figure 2 depicts the aggregated data for built facilities in relation to their use class, as well as in relation to their location (i.e. inside or outside the planning boundaries of the city). As can be seen, Urban fabric (1.1.1, 1.1.2) slightly dominates with 18.01 km2 or 73% of the total area the Industrial units (1.2.1), which cover only 6.74 km² or 27% of the total built-up area.

In terms of territorial affiliation, the Urban fabric detected in the first and second contact zones occupies a total built-up area of 18.01 km²,with an almost equal representation of 8.97 km² or 49.8% within the GUP and 9.04 km² or 50.2% outside the GUP. In the first contact zone, this category represents 17.4% or 3.13 km² of the total built area, while in the second contact zone its spread almost doubles to 24.2% or 4.36 km² of the total built area. Industrial units occupy a total built area of 6.74 km² and are more dominant within the GUP with 4.2 km² or 62.9%, compared to outside the GUP (2.4 km² or 36.3% of the built area). In the first contact zone, this category represents 11.4% or 0.77 km² of the total built area, while in the second contact zone its coverage doubles again to 24.0% or 1.62 km² of the total built area.

Stratified analysis allows us to establish that the built facilities are predominantly present within the GUP with 13.21 km² or 53.4%. However, it is important to note that the built facilities in the first contact zone represent 3.90 km² or 15.8%, and 5.98 km² or 24.2% in the second contact zone. Their total relative value is 40%, which is almost close to the total built-up area within the GUP. Given the intensity and quantity of the build-up area in the contact areas of Skopje, these results confirm the interest of the research problem on behalf of the phenomenon of urban expansion in the sub-urban area of the city.

The percentage of built-up areas in settlements and agglomeration units in the first and second contact zones of the Skopje Region is analysed on the basis of the built content in 2022. The territorial framework is defined according to the cadastral municipalities, individually or within the established agglomeration (Figure 3). The results help us to classify settlements and agglomerations with a low or high percentage of built-up areas in the first and second contact zones of the city of Skopje.

In the settlements of the first contact zone, the average value of the built-up area is 4.2%. 8 out of the 18 settlements display a high percentage of construction. Vizbegovo has the highest percentage at 14.7%. There is a tendency for settlements with the highest percentage of built-up areas to be located in the north-western part of the first contact zone of the city of Skopje.

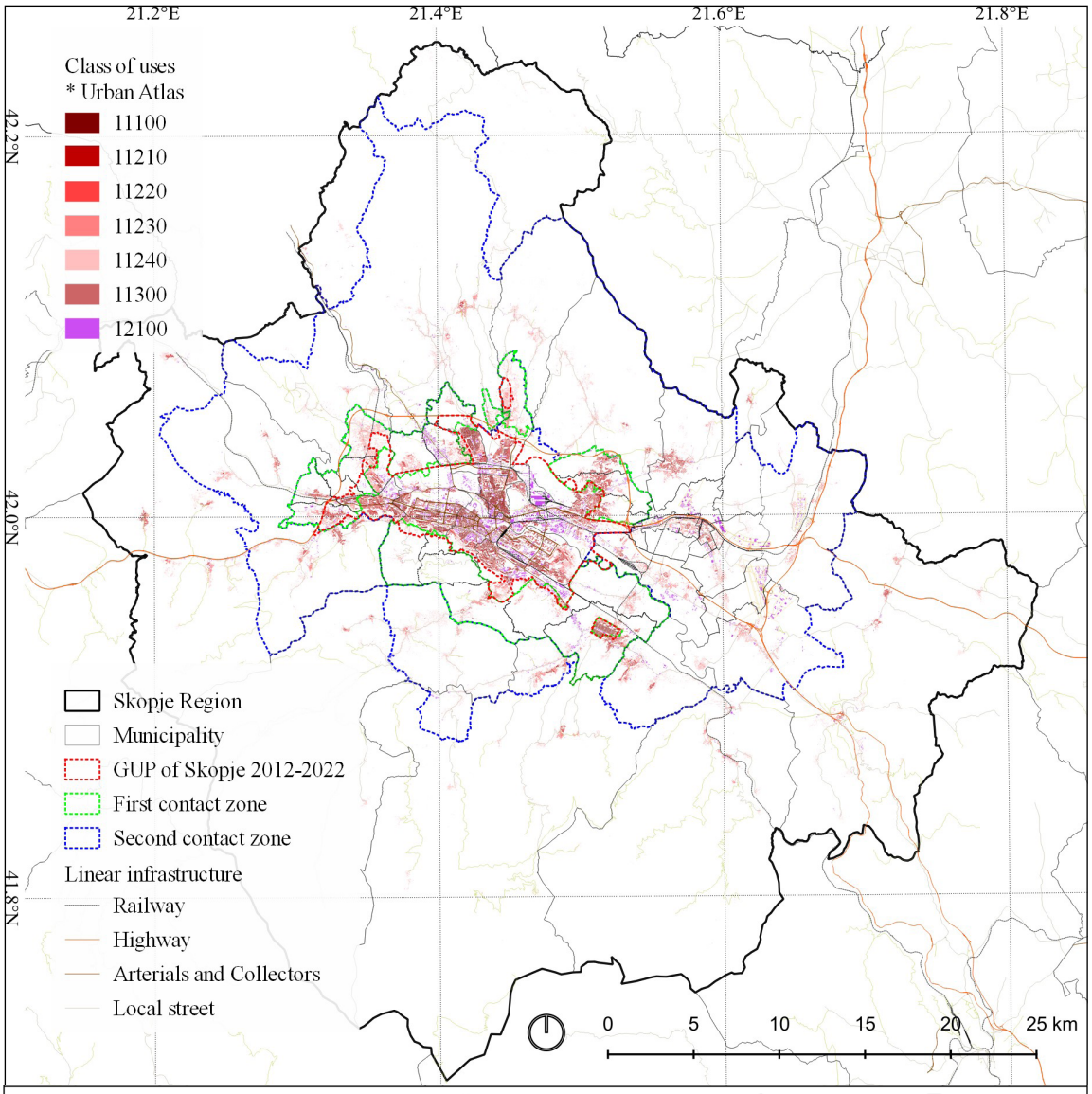
In the agglomeration units of the second contact zone, the average value of the built-up area is 1.0%. 7 out of the 14 agglomerations there have a high percentage of build-up area. Ilinden 1 enjoys the highest percentage at 2.79%. There is a tendency for the the agglomerations with the highest percentage of built-up areas to be located in the eastern part of the second contact zone of the city of Skopje.

The two specific cases with the highest value for population density and percentage of built-up area in the first and second contact zones are chosen for more in-depth analysis below. (Figure 3).

## Chronological analysis of the built-up area in two case studies

The case study from the first contact zone – the settlement of Vizbegovo – is located in the

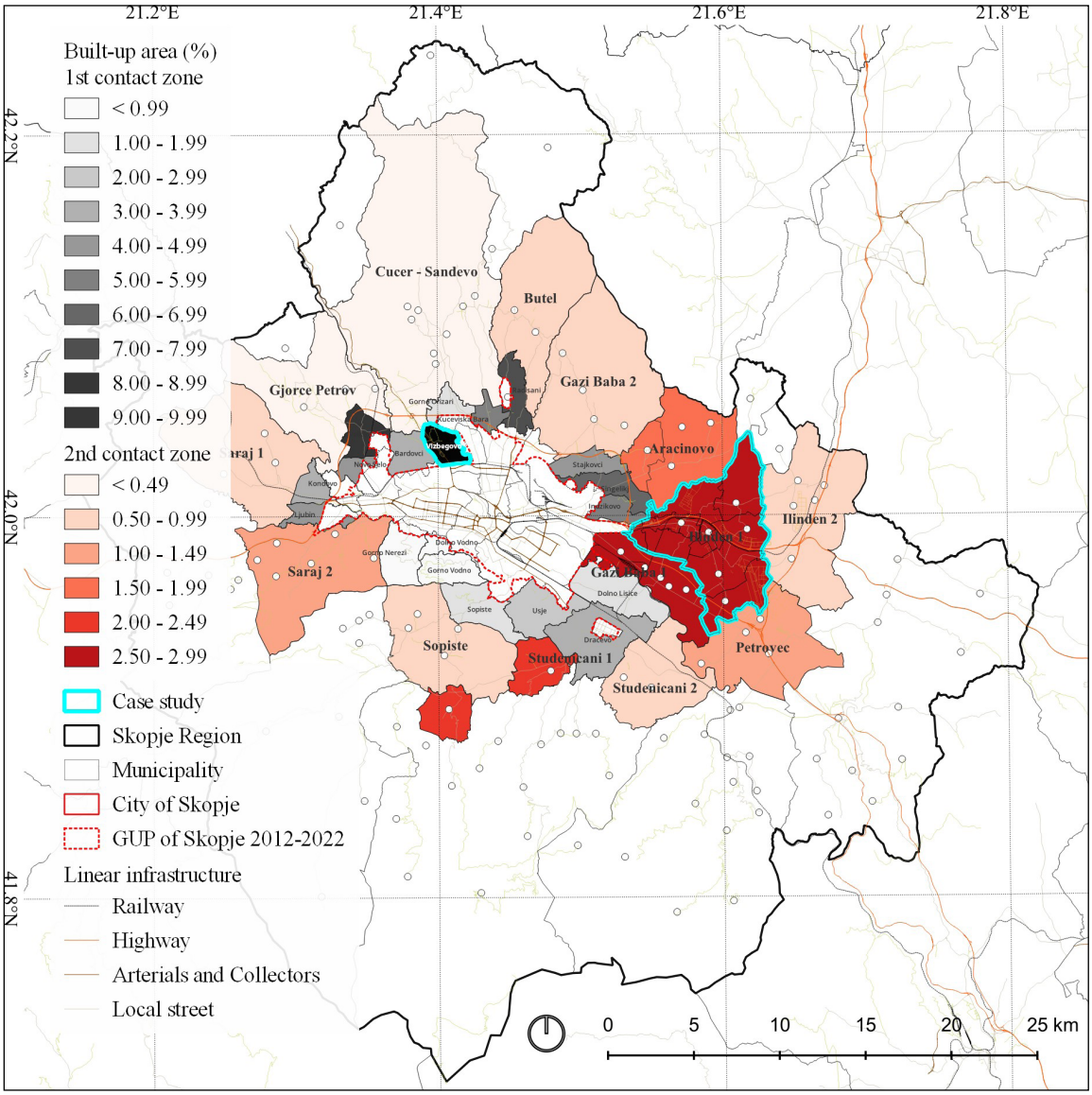
Figure 2. Analysis of the built facilities in the Skopje region through their affiliation within or outside the planning boundaries of the city of Skopje in 2022




| | | GUP | | 1st contact zone | | 2nd contact zone | | ∑ | |
|---|---|---|---|---|---|---|---|---|---|
| **1.1.1** | Continuous urban fabric | **(km²)** | **%** | **(km²)** | **%** | **(km²)** | **%** | **(km²)** | |
| 11100 | (sealed land > 80%) | 4.02 | | 0.03 | | 0.03 | | 4.11 | |
| **1.1.2** | Discontinuous urban fabric | | | | | | | | |
| 11210 | (50% - 80%) | 3.46 | | 0.86 | | 0.78 | | 5.28 | |
| 11220 | (30% - 80%) | 0.89 | | 0.80 | | 0.97 | | 2.92 | |
| 11230 | (10% - 30%) | 0.46 | | 0.84 | | 0.97 | | 2.48 | |
| 11240 | (sealed land < 10%) | 0.15 | | 0.56 | | 1.57 | | 3.14 | |
| **1.1.3** | Isolated structures | | | | | | | | |
| 11300 | | 0.00 | | 0.01 | | 0.04 | | 0.07 | |
| | | **8.97** | 49.8% | **3.13** | 17.4% | **4.36** | 24.2% | **18.01** | ∑ 1.1. |
| **1.2.1** | Industrial, commercial, public, military and private units | | | | | | | | |
| 12100 | 12100 | 4.24 | 62.9% | 0.77 | 11.4% | 1.62 | 24.0% | **6.74** | ∑ 1.2.1. |
| | | **13.21** | 53.4% | **3.90** | 15.8% | **5.98** | 24.2% | **24.75** | ∑ 1.1. + 1.2.1 |

*Source: Microsoft Building Footprints, 2022 & Urban Atlas, 2018*

Figure 3. Density of built-up areas in settlements and agglomerations from the first and second contact zones of the city of Skopje in 2022




*Source: Microsoft Building Footprints, 2022*

municipality of Butel and belongs to the cadastral municipality (KO) of Vizbegovo. The case study from the second contact zone – Ilinden 1 - is located in the municipality of Ilinden, which consists of the cadastral municipalities (KO) Ilinden, Marino, Kadino, Mralino, Bunardzik and Ajvatovci. The results for these two territorial fragments are presented in comparative perspective and are based on analysis of the chronological tendencies of the built-up area according to:

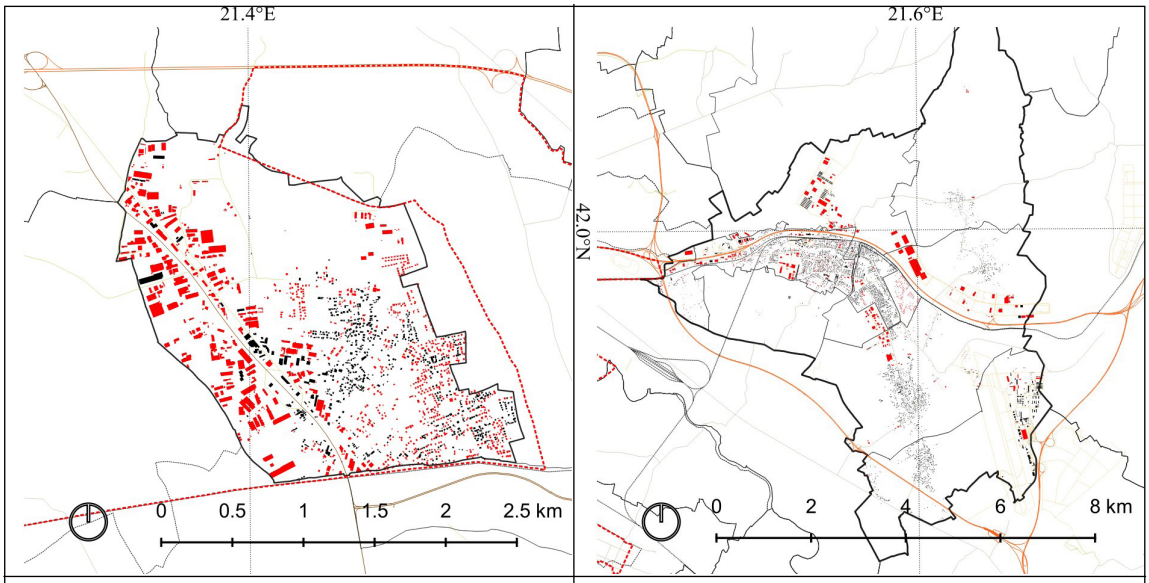
- percentage of built-up areas;
- planning use class.

The chronological overview covers a timeframe of almost 20 years (between 2003 and 2022), for which data were available.

The growth index of the built-up area in the cadastral municipality of Vizbegovo from the first contact zone stands out with a staggering 400 index points, i.e. a 300% growth of the built features during the period studied. The growth index of the built-up area in the agglomeration Ilinden 1 from the second contact zone exhibits a solid 192 index points, i.e. a 92% growth of the built features during the same timeframe (Figure 4).

The purpose of the surface objects is formally and legally defined by the given planning use class, a parameter taken from the planning documents.

Figure 4. Chronological trends of the built-up area and planning use class for the territorial fragments of the cadastral municipality of Vizbegovo and agglomeration of Ilinden 1, 2003-2020




Vizbegovo

| 2003 | | 2020 | | Σ | | I | |
|---|---|---|---|---|---|---|---|
| km² | % | km² | % | km² | % | *i* | % |
| 0.13 | 24.3 | 0.39 | 75.7 | 0.52 | 100 | 400 | 300 |

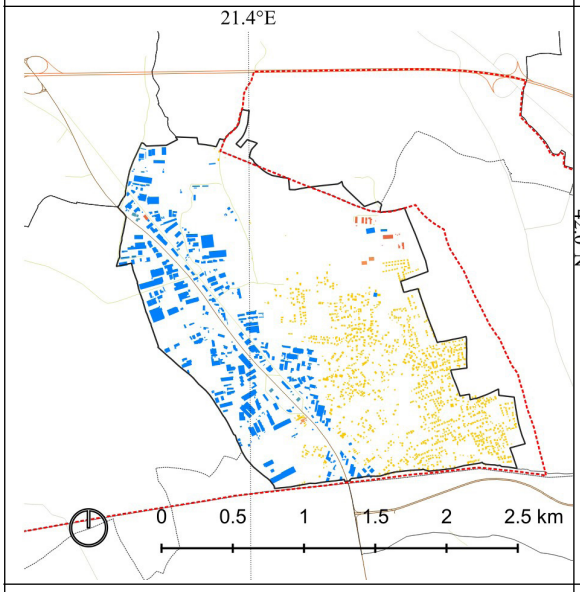
M=1:50,000




Ilinden 1

| 2003 | | 2020 | | Σ | | I | |
|---|---|---|---|---|---|---|---|
| km² | % | km² | % | km² | % | *i* | % |
| 0.69 | 51.9 | 0.64 | 48.1 | 1.33 | 100 | 192 | 92 |

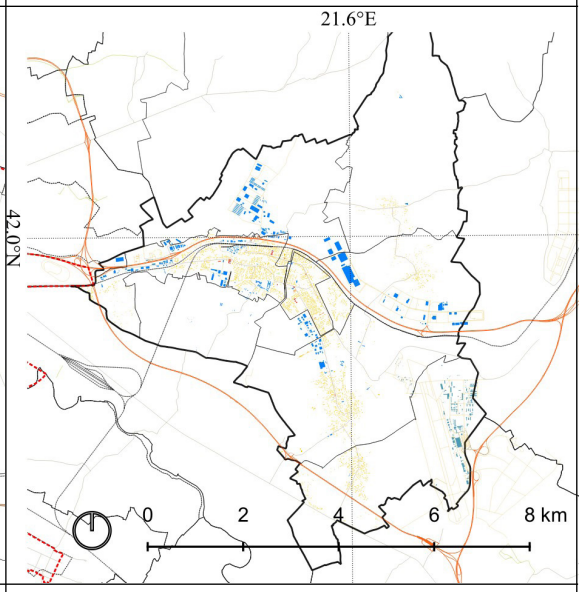
M=1:150,000




Vizbegovo

| | 2003 | | 2020 | | I | |
|---|---|---|---|---|---|---|
| | km² | % | km² | % | *i* | % |
| A1 | 0.09 | 67.7 | 0.19 | 36.6 | 211 | 111 |
| G2,G3,G4 | 0.04 | 30.6 | 0.32 | 61.1 | 800 | 700 |

M=1:50,000




Ilinden 1

| | 2003 | | 2020 | | I | |
|---|---|---|---|---|---|---|
| | km² | % | km² | % | *i* | % |
| A1 | 0.47 | 69.3 | 0.54 | 40.9 | 115 | 15 |
| G2,G3,G4 | 0.09 | 13.6 | 0.60 | 45.1 | 666 | 566 |

M=1:150,000

*Source: Microsoft Building Footprints 2022 & Distribution Portal of the Real Estate Cadastre Agency, 2022*

In both cases, two main use class emerge: (1) use class G – Production, distribution and services, with its sub-classes G2 – light industry, G3 – services and G4 – warehouses, and (2) use class A – Housing, with its sub-class A1 – housing in residential houses. The other use classes are present with a significantly smaller percentage and are therefore excluded from this analysis.

In the cadastral municipality of Vizbegovo from the first contact zone, use class A1 was the dominant use class in 2003, with 0.09 $km^2$ or 67.7% of the total built-up area. The use classes G2, G3 and G4 only covered 0.04 $km^2$ or 30.6% of the total built-up area at that time. This situation is completely revered in 2020, with the use classes G2, G3 and G4 becoming dominant (0.32 $km^2$ or 61.1% of the total built-up area) and use class A1 shrinking to 0.19 $km^2$ or 36.6 % of the total built-up area.

In the agglomeration Ilinden 1 from the second contact zone, the use class A1 was dominant in 2003, with 0.47 $km^2$ or 69.3% of the total built-up area, when use classes G2, G3 and G4 only represented 0.09 km2 or 13.6% of the total built-up area. Again, this trend is revered in 2020, with the use classes G2, G3 and G4 taking the lead at 0.60 km2 or 45.1% of the total built-up area and use class A1 decreasing to 0.54 $km^2$ or 40.9 % of the total built-up area.

The use classes G2, G3 and G4 in the cadastral municipality of Vizbegovo record a growth tendency of 800 index points, i.e. a difference of 700% between 2003 and 2020, while the use class A1 records a non-negligible increase of 211 index points, i.e. a change of 111% –over the same time period. Likewise, in the agglomeration Ilinden 1, the use classes G2, G3 and G4 reveal a growth tendency of 666 index points, i.e. a difference of 566% between 2003 and 2020, while the use class A1 records a non-negligible surge of 115 index points, i.e. a change of 15% over the studied timeframe.

This chronological review offers in both case studies important insights about the drastic growth tendency of the G2, G3 and G4 use classes and the non-negligible increase of the historically dominant use class A1. These results are representative of the overall urban dynamics guided by the territorial governance of the suburban region of the city of Skopje.

## Conclusion

The cartographic and alphanumeric results of this research inform a methodology for continuous regional observation of potential growth and urban expansion. The results also confirm the high/remarkable degree of urban expansion of the city of Skopje towards suburbs, as well as the concentration of construction along the marginal zones of the planning area. Consequently, the contact zone of the planning area is being challenged, although this aspect has so far been ignored in the process of developing the general and detailed planning documents and in territorial governance in general.

This paper sets up a system for continuous monitoring of the trends of the built-up areas, which can allow planning regulations and mechanisms to reflect these dynamics. The holistic approach proposed in this paper to study the evolution of the city and its surroundings highlights the numerous contact zones between Skopje and suburban settlements and identifies the most important aspects for mutual development.

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## Notes

[1] https://land.copernicus.eu/local/urban-atlas

[2] Functional Urban Areas (FUAs) are datasets of contiguous local (administrative) units composed of the "city" and its surroundings, less densely populated local units that are part of the city's labour market and belonging to its "travel zone" (commuting zone). To be included in the commuting zone, local units must have at least 15% of their working population commuting to the city.

**Disclosure statement**

No potential conflict of interest was reported by the author.