Interreg Danube Region
Co-funded by the European Union
Be Ready

Urban heat islands vulnerability and risk assessment

CITY OF ZENICA

Specific objective 1	Provide assessment and operational instruments to cities to better understand UHI drivers & effects
Activity 1.3.	Testing the methodology and tools: conducting vulnerability and UHI risk assessments in the partner cities
Deliverable 1.3.1	City reports from UHI risk assessment
Core writing team	Edina Hodžić, Assistant of the mayor by Authorization – Head of department for economics Ahmed Brkić, Expert Associate for Statistic and Analysis Haris Alić, Senior expert associate for urban planning City of Zenica
Contributing authors	Amra Mehmedić, adviser at public company Grijanje ltd Zenica
Review Editors	Lejla Brljevac, Head of department for urban planning, City of Zenica
Technical Support	Emir Čaplja, Associate for Project Development and Implementation, Zenica Development Ageny ZEDA
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History

Version	Author(s)	Status	Comment	Date
1	Ahmed Brkić Haris Alić Amra Mehmedić	Draft	Data collection	07.02.2025.
2	Ahmed Brkić Haris Alić Edina Hodžić Amra Mehmedić	Final	None	28.02.2025.

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UHI	Urban Heat Island

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1. Introduction

ABOUT THE PROJECT

Urban heat islands (UHI) are the common challenge of the project that 19 partners and 9 ASPs from 12 countries will tackle with the aim to strengthen the preparedness and adaptive capacity of the society to cope with impacts of climate change and foster resilience at city level. The project approach will allow partners, to take targeted, small powerful, context-based measures to deal with UHI in critical urban areas. City pilots will test solutions in three areas: "green acupuncture" (vegetation-based interventions); "white acupuncture" (based on innovative surfaces and materials); and "blue acupuncture" (novel uses of water resources). The approach of jointly developing, testing and evaluating solutions contributes to most effective use of shared expertise for better understanding the effects of UHI in and building institutional capacity at local/regional level, for policy development and practical interventions.

ABOUT THE REPORT

The main aim of the document Deliverable 1.3.1 City reports from UHI risk assessment is to test the join methodology and tools developed for 4 vulnerability elements (figure 1): exposure, sensitivity, preparedness and adaptive capacity and risk groups (Deliverable 1.1.1. Shared methodology and tools for UHI vulnerability and risk assessment).

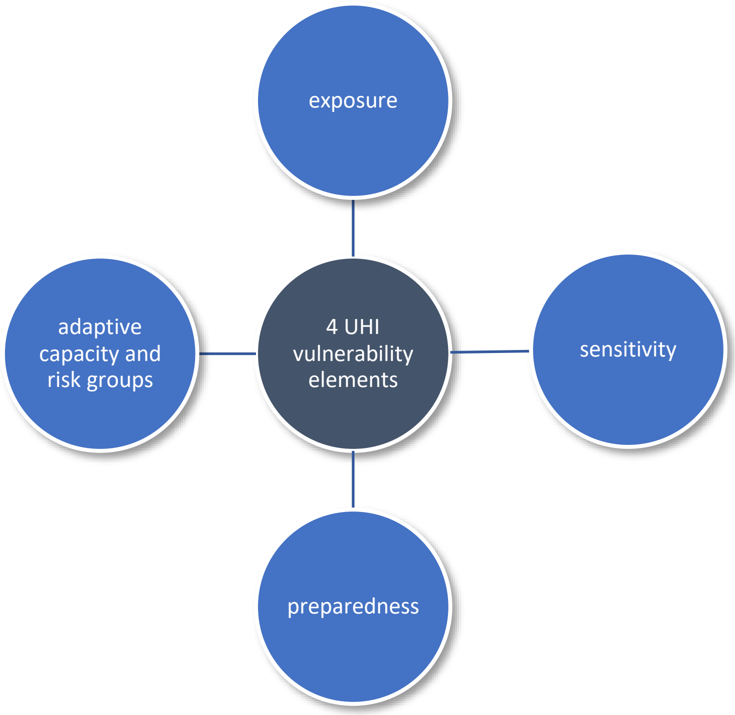


Figure 1: 4 UHI vulnerability elements

Project partner cities will carry out UHI risk assessment for their cities as a preparatory activity for the implementation of the pilot actions as part of the Specific objective 2 Co-creating, testing, and validating jointly developed solutions to mitigate UHI effects in cities. The assessments will draw upon historical data and statistics, and other information and data from different sources. The risk assessment will be carried out with the support of the local coalitions (Activity 1.3), which will enable community engagement and raising awareness city-wide about the project objectives and expected results. The partner cities will choose which city zones to be included in the risk assessment, but to ensure comparability of the results and of the applicability and usability of the tools, we expect the UHI assessment to cover an area with high density of construction; an industrial zone; a densely populated area with mid- to low-income residents. Task leaders are the partner cities (conducting the risk assessment and drafting the resulting report; knowledge partners provide consultation and feedback.).

Each city will develop one city report supported by knowledge partners. The city report will include analysis of the usability of the tools and recommendations for adjustment of the methodology, where needed. The reports feed into the City Climate Sandbox concept and pilots.

AREA OF THE INTERVENTION

Territorial context

City of Zenica

Region Zenica-doboj canton

Entity Federation of Bosnia and Herzegovina

Country Bosnia and Herzegovina

Statistical data

Surface Area: 550km^2

Population: 110.663

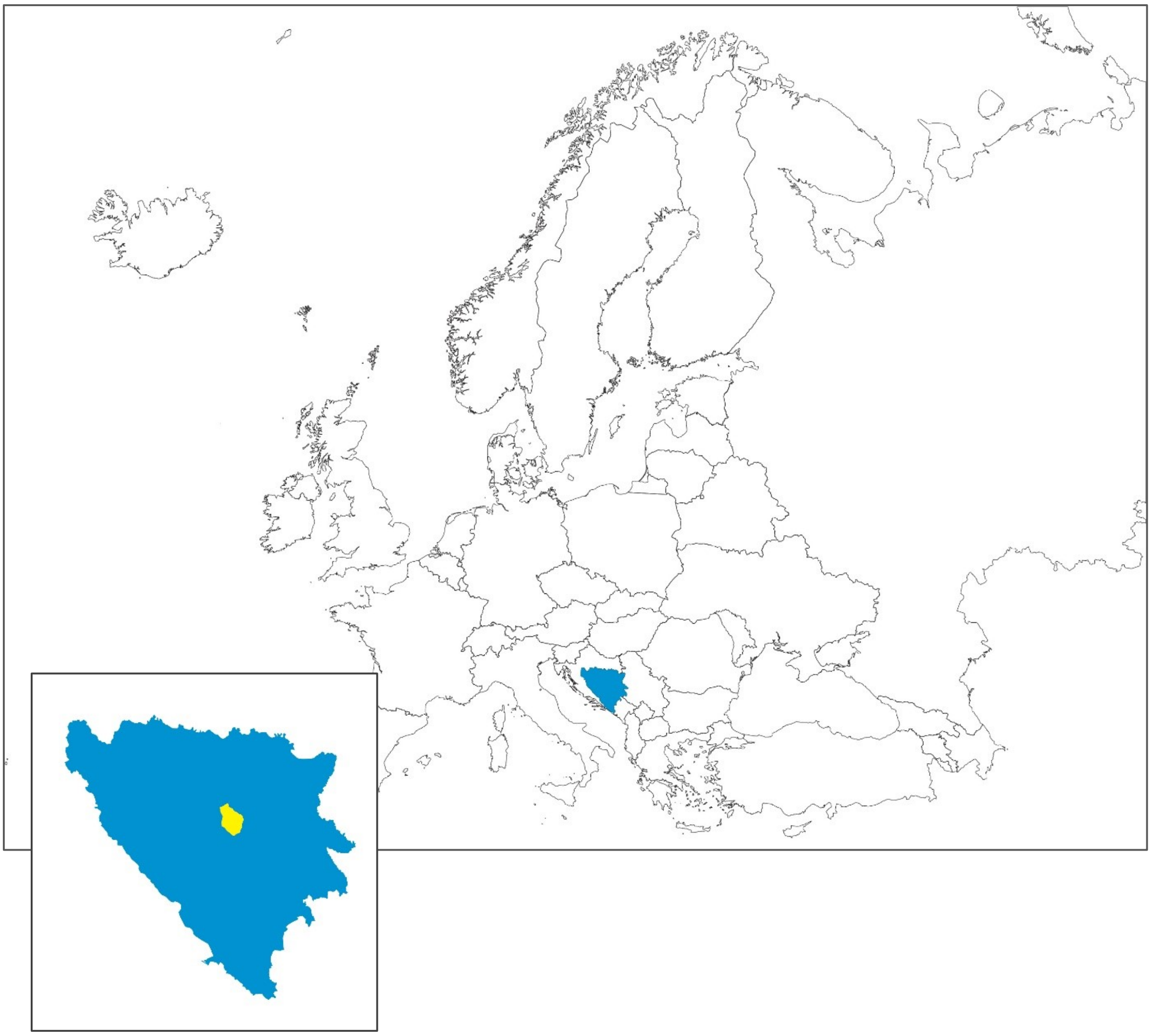
Density: 200/km2

Minimum Wage (€/year) 6.000 euros/year

ABOUT THE CITY

The City of Zenica, located centrally in Bosnia and Herzegovina, sits approximately 70 kilometers northwest of the capital, Sarajevo. It is the fourth largest city in the country and serves as the administrative center of Zenica-Doboj Canton, accommodating around 30% of the total 364,433 inhabitants of the canton. With an area of approximately 550 km2, Zenica boasts a notable amount of green spaces within its urban landscape, comprising 58% of the total urban area. It is a fourth largest city in Bosnia and Herzegovina, after Sarajevo, Banja Luka and Tuzla.

Graphical image of City of Zenica on the country and global level



2. Methodology of the assessment

SUMMARY OF THE PROCESS

The analysis was conducted using a methodology developed specifically for assessing Urban Heat Island (UHI) effects, designed to guide cities participating in the project. This methodology focuses on four key vulnerability elements: exposure, sensitivity, preparedness, and adaptive capacity, alongside risk groups. The ultimate objective for partner cities, including Zenica, was to identify UHI impacts and devise solutions to mitigate them, with input from various stakeholders.

The process was structured into four phases: preparatory, starting, active, and final. In the preparatory phase, the methodology was reviewed, and an initial assessment of internal capabilities to perform the analysis was conducted. The starting phase involved organizing a local workshop, collecting relevant data, collaborating with other cities to share ideas, experiences, and challenges. During the active phase, the gathered data was processed, and external experts were consulted for map preparation. This phase also involved preparing the data for the urban climate section of the report and drafting the report itself. The final phase focused on refining the report, which included a review by a scientific partners.

PREPARATORY PHASE

The initial phase included assessment of internal capabilities to perform UHI assessment using methodology for assessing Urban Heat Island (UHI) effects. In starting phase we have organized our first local workshop. In order to secure participative and co-creation process we have invited representatives from public, private, academia and NGO sector. Presentation of UHI risk assessment was a kick off for data collection.

EVENTS/ ACTIVITIES

Several meetings were organised to initiate UHI risk assessment, which included individual meetings with partners on the project as well as serious of meetings of our project team. During these meetings we have discussed which data is available, how to gather it and graphically present given the fact that urban planning department does not use QGIS data. City of Zenica is in a process of getting a new Urban plan which is being prepared with Cantonal Institute for urbanism. During active phase we have obtained external expertise for map preparation including data from QGIS.

TIMELINE OF THE PROCESS

September	October	November	December	January	February
Local workshop	Stakeholder meeting	QGIS data collection	Climate data collection	Drafting report	Final report

3. Urban climate

GENERAL INFORMATION ABOUT URBAN CLIMATE TRENDS

Zenica is located in the valley of the Bosna River, which originates in Ilidža near Sarajevo, and is surrounded by mountain ranges that influence airflows, potentially worsening the effects of air pollution in the valley. These mountains have also restricted and shaped the city's urban development, resulting in an elongated zone of expansion along both sides of the Bosna River. The city has a mid-continental climate, marked by warm summers and cold winters. Moderate wind speeds and calm weather conditions often limit the dispersion of pollutant emissions from local industries, energy production, and vehicle traffic. Additionally, the city is affected by global climate change driven by human activities. Projections for Zenica-Doboj Canton suggest significant warming in the coming decades, along with a notable decrease in precipitation, particularly during the summer months.

Zenica, which had been a relatively small town before the establishment of the Ironworks, began to grow rapidly as the company expanded. The Ironworks became the backbone of Zenica's economy, providing thousands of jobs and attracting workers from various parts of Bosnia and Herzegovina and beyond. This has dictated and intensive construction of settlements and collective housing facilities in period from 1960 to 1980. They were built mostly in today's urban area, which is the subject of this project.

We encountered challenges in collecting meteorological data for Zenica. The city relies on a single measuring station operated by the Hydrometeorological Institute of FBiH, which unfortunately was malfunctioning for most of 2024. As a result, we obtained data for that year from Alba Zenica, a local utility company that operates its own measuring station to support its business activities. The analysis presented here is based on the data that was accessible to us. There are some shortcomings in this analysis due to limitations in the available data. However, the data we were able to collect, particularly regarding air temperature and precipitation, clearly indicate an evident warming trend in Zenica. This trend aligns with broader patterns of climate change, highlighting the need for continued monitoring and adaptive strategies for managing the city's environmental challenges.

Air Temperature

The average monthly temperatures in Zenica vary throughout the year, reflecting its mid-continental climate. Winters are cold, with average temperatures in January typically ranging around 3°C, while summer months bring warmth, with July and August averaging temperatures between 25°C and 26°C. Over recent years, the temperatures have shown some variation, with 2024 recording an average temperature of 15.0°C, slightly higher than the 2023 average of 14.0°C. While the city generally experiences mild springs and autumns, the data highlights the significant influence of seasonal shifts, with the lowest temperatures occurring in January and February, and the highest in the summer months of June, July, and August. This temperature pattern is typical for Zenica, with occasional fluctuations due to annual climatic variations.

Table 1. Average monthly temperatures

CITY OF ZENICA AVERAGE MONTHLY TEMPERATURES													
Year	JAN	FEB	MARC H	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	Aver. Temp.
2024	3,4	9,8	12,0	15,2	18,8	23,3	25,6	26,6	19,9	16,1	5,6	3,2	15,0
2023	4,1	4,6	9,5	11,0	17,3	21,3	24,8	23,7	21,3	17,3	8,1	5,2	14,0
2022	0,2	4,8	5,3	10,6	17,8	22,9	23,1	21,7	16,0	13,8	7,9	5,0	12,0
2021	2,1	5,5	5,7	9,3	16,1	21,8	23,7	21,9	17,4	9,5	7,4	3,6	12,0
2020	-0,3	5,6	7,4	12,2	15,1	19,4	21,2	21,0	17,7	11,5	6,2	4,7	11,8
2019	-0,6	3,8	8,6	12,4	14,0	22,4	21,8	23,0	17,4	13,1	10,6	3,7	12,5
2018	3,7	1,4	6,0	15,3	18,4	19,9	21,2	22,1	16,8	13,7	7,9	1,0	12,3
2017	-4,3	4,4	8,5	9,6	15,4	19,7	/	/	/	/	/	/	/
2016	1,3	7,2	7,5	13,4	15,1	20,8	22,5	20,0	16,8	10,8	6,4	-0,3	11,8
2015	1,1	2,6	6,6	10,9	17,4	19,6	24,3	23,2	18,0	12,2	5,7	0,7	11,9
2014	5,4	7,8	9,3	12,0	15,1	19,1	20,8	20,5	16,2	12,9	8,9	2,8	12,6
2013	2,9	2,9	6,3	13,1	16,2	19,9	22,0	22,8	16,2	13,3	7,5	1,0	12,0

Source: Federal Hydrometeorological Institute (https://www.fhmzbih.gov.ba/latinica/KLIMA/godisnjaci.php)

Zenica's average annual temperature has ranged from 11.8°C in 2020 to 15.0°C in 2024, reflecting some variation year to year, but with an overall trend toward warmer temperatures. 2024 stands out as the warmest year, with particularly high temperatures in the summer months, such as 26.6°C average temperature in August. This shift in temperature patterns aligns with broader signs of climate change, with the city experiencing more extreme temperature fluctuations in recent years.

Seasonally, Zenica sees cold winters, with January and February often dipping close to or below freezing. The coldest winter on record occurred in January 2017, with an average temperature of -4.3°C. In contrast, spring and fall have shown a noticeable warming trend. Spring temperatures gradually rise from around 5°C in March to 18°C in May, with 2024 being particularly warm, especially in May, when temperatures reached 18.8°C. Fall has also become warmer in recent years, with September and October in 2023 and 2024 exceeding 21°C on average, much higher than in previous years.

Summer remains consistently warm, with temperatures consistently above 20°C, especially in July and August. 2024 saw a particularly hot summer, marking an outlier for high temperatures compared to previous years.

Overall, Zenica's climate shows a clear pattern of rising temperatures, particularly in recent years, indicating the ongoing impacts of climate change. While winters still bring cold weather, the warmer trends in spring, summer, and fall highlight a shift toward longer, hotter seasons, with noticeable impacts on seasonal temperature extremes.

Table 2. Number of days with temperatures > 30,0 °C (hot days)

Year	May	June	July	August	September
2024	4	18	**27**	**31**	11
2023	1	9	24	20	**15**
2022	**9**	**22**	24	18	3
2021	4	15	21	18	9
2020	6	10	14	22	9
2019	1	18	18	24	6
2018	2	10	15	21	3
2017	4	19			
2016	5	10	18	13	7
2015	7	10	25	23	12
2014	4	9	12	12	0
2013	4	12	14	17	4

Source: Federal Hydrometeorological Institute (https://www.fhmzbih.gov.ba/latinica/KLIMA/godisnjaci.php)

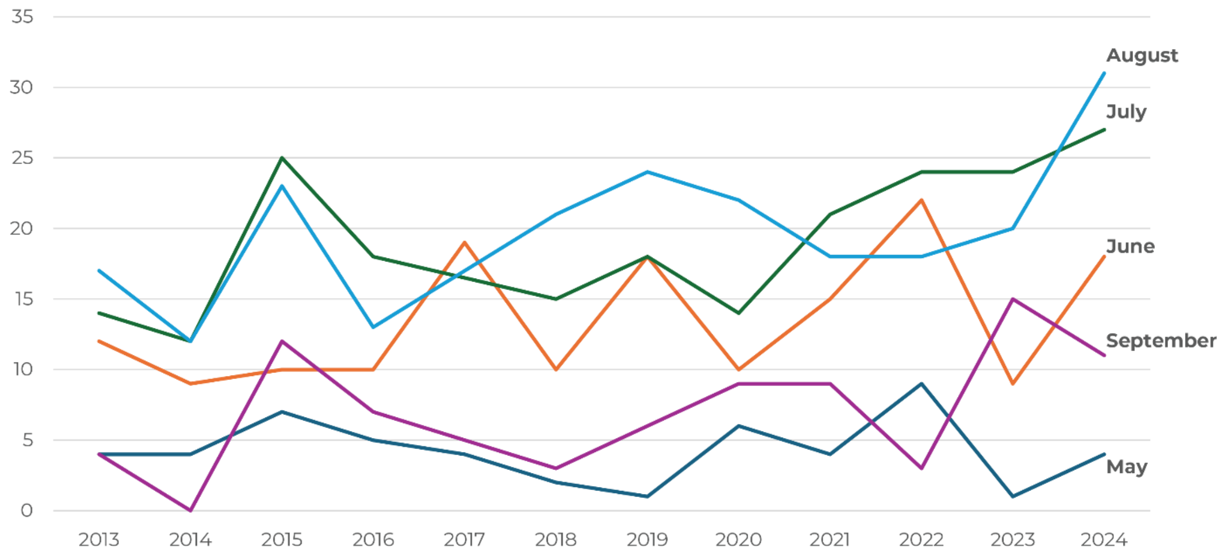
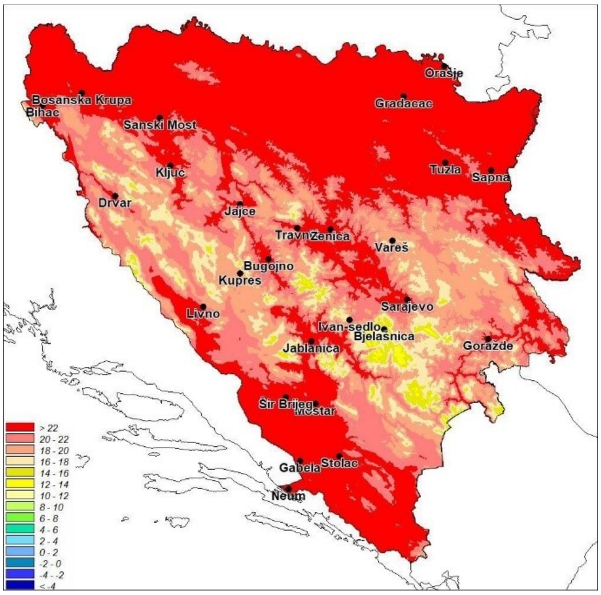


Diagram 1. Trend of hot days

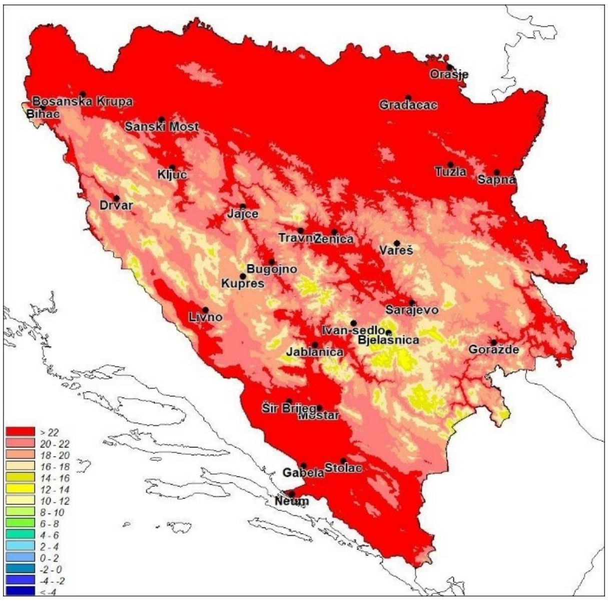
The analysis of hot days in Zenica over the past decade reveals a clear warming trend. The year 2024 stands out with the highest number of hot days—91 days above 25°C—significantly surpassing previous years. In contrast, 2014 and 2018 had the fewest hot days, with 37 and 51 days, respectively. The summer months, particularly July and August, consistently see the highest number of hot days, with July often recording the peak. Notably, there has been a marked increase in the number of hot days, especially between 2019 and 2024, which aligns with broader patterns of climate change and rising temperatures in the region. This trend underscores the growing impact of global warming on local climate conditions in Zenica. The number of days with temperatures exceeding 30°C varies considerably across the years. 2024 stands out with a significant number of hot days, particularly in the summer months, while years like 2013 and 2014 were much cooler. The data reflects an increasing trend in the occurrence of hot days in recent years, with 2024 and 2015 recording the most extreme heat events.

On August 13th and 14th, 2024, Zenica was the hottest city in Europe with record-breaking temperatures. On August 13th, the temperature in Zenica reached 42.6°C, the highest in Europe that day. The day before, on August 12th, the temperature was 41.4°C, also the hottest in Europe on that day. These high temperatures were part of a larger heatwave that affected Bosnia and Herzegovina during August 2024



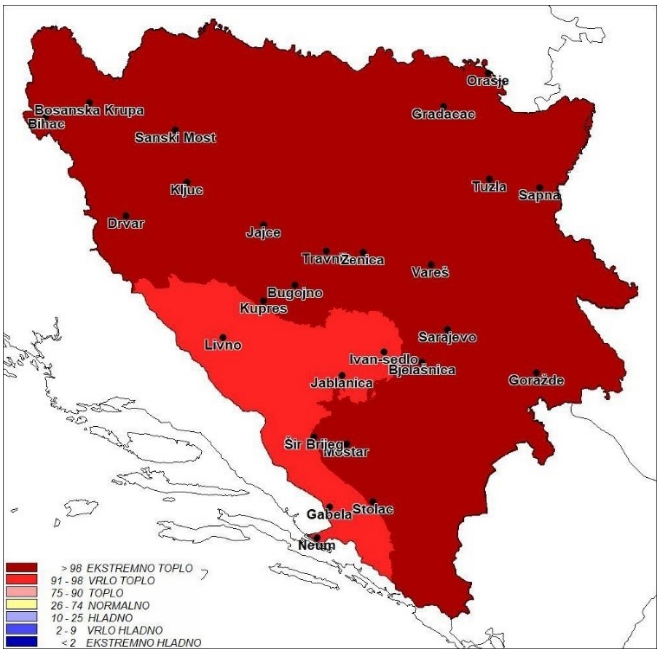
Map 1 Spatial distribution of average air temperature (°C) for summer 2024

Source: Federal Hydrometeorological Institute (https://www.fhmzbih.gov.ba/latinica/KLIMA/analiza-godina.php)



Map 2 Anomalies of average air temperature (°C) compared to the average temperature for summer 2024

Source: Federal Hydrometeorogical Institute (https://www.fhmzbih.gov.ba/latinica/KLIMA/analiza-godina.php)



Map 3 Spatial distribution of average temperature for summer 2024 using the percentile

Source: Federal Hydrometeorogical Institute (https://www.fhmzbih.gov.ba/latinica/KLIMA/analiza-godina.php)

Table 3. Deviation of air temperature in 2024 in relation to reference series 1991-2020

STATION	JUNE	JULY	AUGUST	SUMMER
Sarajevo	3,2	3,3	3,9	3,5
Tuzla	3,0	3,3	4,2	3,4
Zenica	**2,4**	**2,5**	**4,3**	**3,1**

Source: Federal Hydrometeorogical Institute

In 2024, all three stations (Sarajevo, Tuzla, and Zenica) experienced significantly higher temperatures than the 1991-2020 reference period. The deviations ranged from +2.4°C to +4.3°C across the summer months, with the highest deviations observed in August. Sarajevo and Tuzla saw the largest temperature increases in August, with deviations of +3.9°C and +4.2°C, respectively. Overall, the summer temperature deviations were relatively similar across the stations, with Sarajevo having the highest summer average (+3.5°C). This suggests a generally warmer summer in 2024 compared to the long-term average.

Precipitation

In 2024, Zenica experienced significantly lower annual precipitation, with just 514.1 mm of rainfall, making it the driest year in the dataset. This marked a notable departure from the previous years, with the summer months, particularly, seeing considerably less rainfall than in past years. The year 2024's dry conditions contrast sharply with those of 2014, which recorded the highest total precipitation at 1147.9 mm. This extreme amount of rainfall was especially concentrated in the spring and summer, particularly in April, May, and August, making 2014 the wettest year by far.

Table 4. Total precipation in City of Zenica for period 2013 - 2024

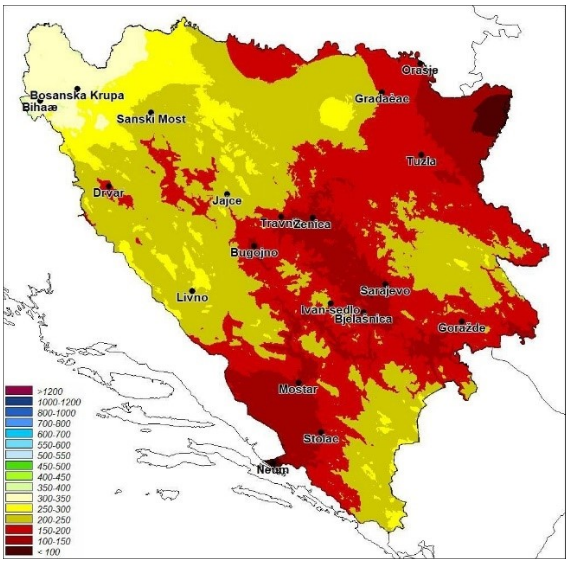
Year	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec	Total
2024	36,5	27,1	47,8	45,9	58,5	29,4	20,2	15,8	84,0	4,7	86,0	58,2	**514,1**
2023	72,0	56,3	65,4	73,2	161,9	77,7	51,7	46,7	49,1	26,5	137,0	42,1	**859,6**
2022	30,7	35,6	3,7	64,6	117,7	54,5	77,7	59,9	121,1	7,9	93,6	89,2	**756,2**
2021	74,7	17,2	56,7	45,9	42,3	34,7	55,0	139,6	34,8	127,3	102,9	124,5	**855,6**
2020	19,9	40,5	11,5	15,5	30,3	64,6	27,1	16,6	21,9	77,6	21,8	91,2	**438,5**
2019	43,0	63,6	28,7	76,2	13,4	105,1	87,9	26,8	19,7	21,2	85,8	64,0	**635,4**
2018	47,6	44,5	48,8	21,8	22,2	32,4	122,7	45,0	15,4	34,3	41,4	48,5	**524,6**
2017	44,9	48,0	40,1	107,6	72,3	44,5	77,0	4,1	20,0	99,0	87,4	32,4	**677,3**
2016	41,7	106,1	69,1	44,6	93,7	67,5	115,8	63,8	66,0	64,8	90,3	8,9	**832,3**
2015	89,0	46,5	93,4	42,9	34,9	67,2	46,1	25,9	31,8	132,7	70,0	3,5	**683,9**
2014	17,8	28,7	37,7	200,3	182,2	102,3	90,4	133,5	189,1	60,5	37,9	67,5	**1147,9**
2013	83,6	105,9	101,8	27,4	128,8	48,1	50,4	26,8	61,0	37,0	74,9	3,7	**749,4**

Source: Alba ltd Zenica, 2024

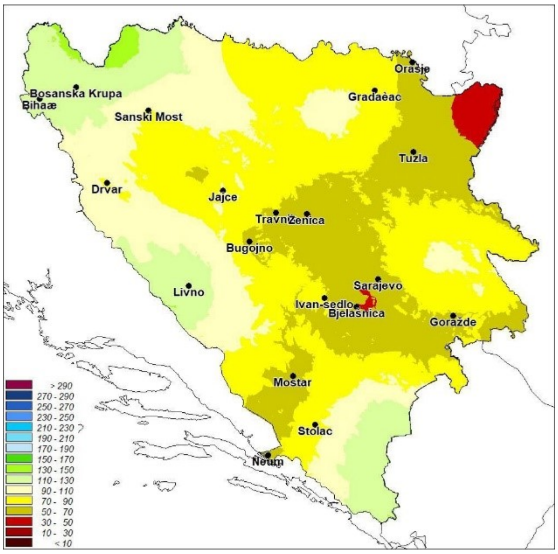
In comparison, 2023 and 2022 both experienced relatively high precipitation levels, with totals of 859.6 mm and 756.2 mm, respectively. These years were wetter than 2024, but their rainfall amounts were moderate in comparison to 2014's extremes. Notably, 2023 had consistent rainfall across most months, leading to a balanced distribution of precipitation throughout the year. 2022, while wetter than 2024, also did not see extreme fluctuations that characterized 2014.

Over the years, Zenica has experienced considerable variability in precipitation, with both extremely wet years (like 2014) and notably dry years (like 2024). While May, June, and July remain the wettest months in most years, there are noticeable shifts, such as the reduced rainfall in 2024. The data reflects broader climate trends, with years like 2014 indicating a higher frequency of extreme weather events, and 2024 pointing toward potential shifts in long-term precipitation patterns. The reduced rainfall in 2024, particularly in the summer, could be a sign of increasingly frequent drought conditions, which are becoming more common in many parts of the world due to global warming.

These fluctuations, especially when viewed over a longer period, underscore the need to recognize and adapt to the changing climate, as such patterns may become more pronounced in the future.



Map 4 Spatial distribution of total precipitation for summer 2024 (mm)



Map 5 Spatial distribution of anomalies of total precipitation for the summer of 2024 in (%)

(https://www.fhmzbih.gov.ba/latinica/KLIMA/analiza-godina.php)

Surface Temperature

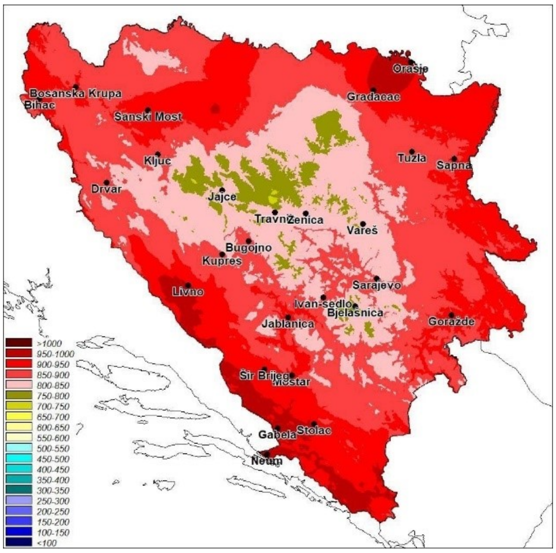
No available data

Solar Radiation

Although the Zenica area benefits from a favorable solar position, the number of sunlight hours is very low. Over the course of a year, Zenica receives approximately 1,516 hours of sunshine, averaging just 4.15 hours per day. There is a significant disparity between the number of sunny hours and the seasons. In fact, any one summer month receives more sunlight than November, December, and February combined. In December, the sun shines for only 0.83 hours per day, while in July, it shines for about 7.6 hours per day.

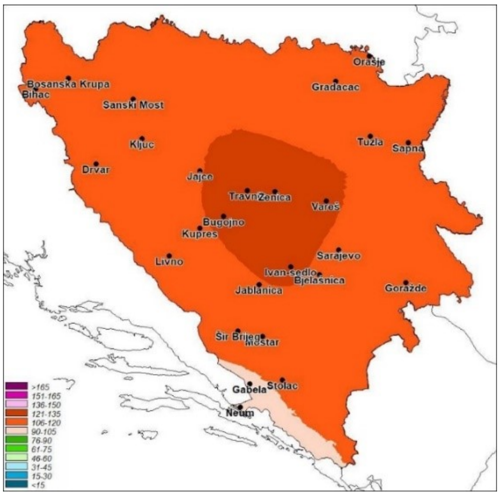
This lack of sunlight is primarily due to the high levels of air pollution over Zenica, which is especially severe during the winter months. In areas with lower air pollution, outside of urban area, peripheral valleys, and mountains, the number of sunny days is significantly higher.

However, in summer of 2024, the number of sunshine hours exceeded the thirty-year average (1991–2022) at all measuring stations, including Zenica. Zenica recorded nearly 100 more hours of sunshine than the average for this period.



Map 6 Spatial distribution of solar radiation (h) summer of 2024

(https://www.fhmzbih.gov.ba/latinica/KLIMA/analiza-godina.php)



Map 7 Spatial distribution of solar radiation (%) from normal values in summer 2024

(https://www.fhmzbih.gov.ba/latinica/KLIMA/analiza-godina.php)

Humidity

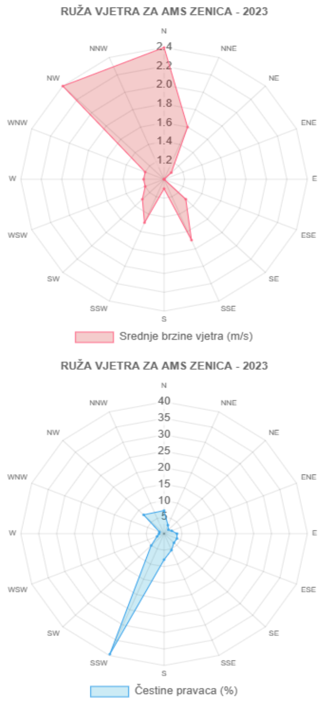
The relative humidity from October to February is very high, ranging from 80% to 85%, while from March to September, it varies between 70% and 77%. This pattern of relative humidity contributes to air pollution. Insolation also plays a significant role in the climate of the region, particularly when it comes to the location and construction of certain buildings. The maximum insolation occurs between June and September, while the minimum is observed from November to February.

Cloud cover is closely linked to insolation, with an inverse relationship between the two. Wind has, under the given circumstances, become one of the primary factors influencing the Zenica area.

Wind Speed and Direction

The flow of air is influenced by the general atmospheric circulation, so the occurrence of local air currents in the Zenica region has a lesser impact on the formation of winds. Due to the natural isolation of the Zenica basin, there are very few windy days, which favors the formation and stagnation of smog and fog. The ratio of days with winds to calm days during measurement periods ranges from 29.5:70.5 to 41.5:58.5. In peripheral, especially mountainous areas, winds are more frequent and more pronounced, particularly in the winter period. The greatest number of calm days occurs between September and January, with the fewest occurring between March and June.

The northern wind predominantly blows in winter, while other winds mostly occur during the transitional seasons. This wind system aligns with the general air circulation system in the Balkans. Wind speed ranges from 2.2 to 3.3 m/sec.



Map 8 – Rose of the winds (https://www.fhmzbih.gov.ba/latinica/KLIMA/ruza-vjetra.php)

Summary

In conclusion, Zenica is experiencing noticeable changes in its climate, driven both by natural patterns and the broader impacts of global climate change. Over the past decade, the city has seen rising temperatures, with 2024 marking the warmest year recorded, particularly in summer. The number of hot days, especially those exceeding 30°C, has increased significantly, highlighting a clear warming trend. Seasonal temperature shifts are evident, with winters still cold, but spring, summer, and fall experiencing longer and hotter periods.

Precipitation patterns are also shifting, with 2024 being one of the driest years in recent history, contrasting sharply with previous years like 2014, which was exceptionally wet, causing major floods in Zenica and other parts of the county. This decrease in rainfall, especially during the summer months, signals potential shifts towards drier conditions and more frequent droughts in the future. The city receives limited sunshine throughout the year due to evident air pollution, although in 2024 there was more sunshine than average.

The data indicates that Zenica is becoming more susceptible to the effects of climate change, as rising temperatures and shifting precipitation patterns align with global climate trends.

4. Assessment of the city based on 4 vulnerability elements, exposure, sensitivity, preparedness and adaptive capacity and risk groups

EXPOSURE OF BUILDINGS AND SURROUNDINGS

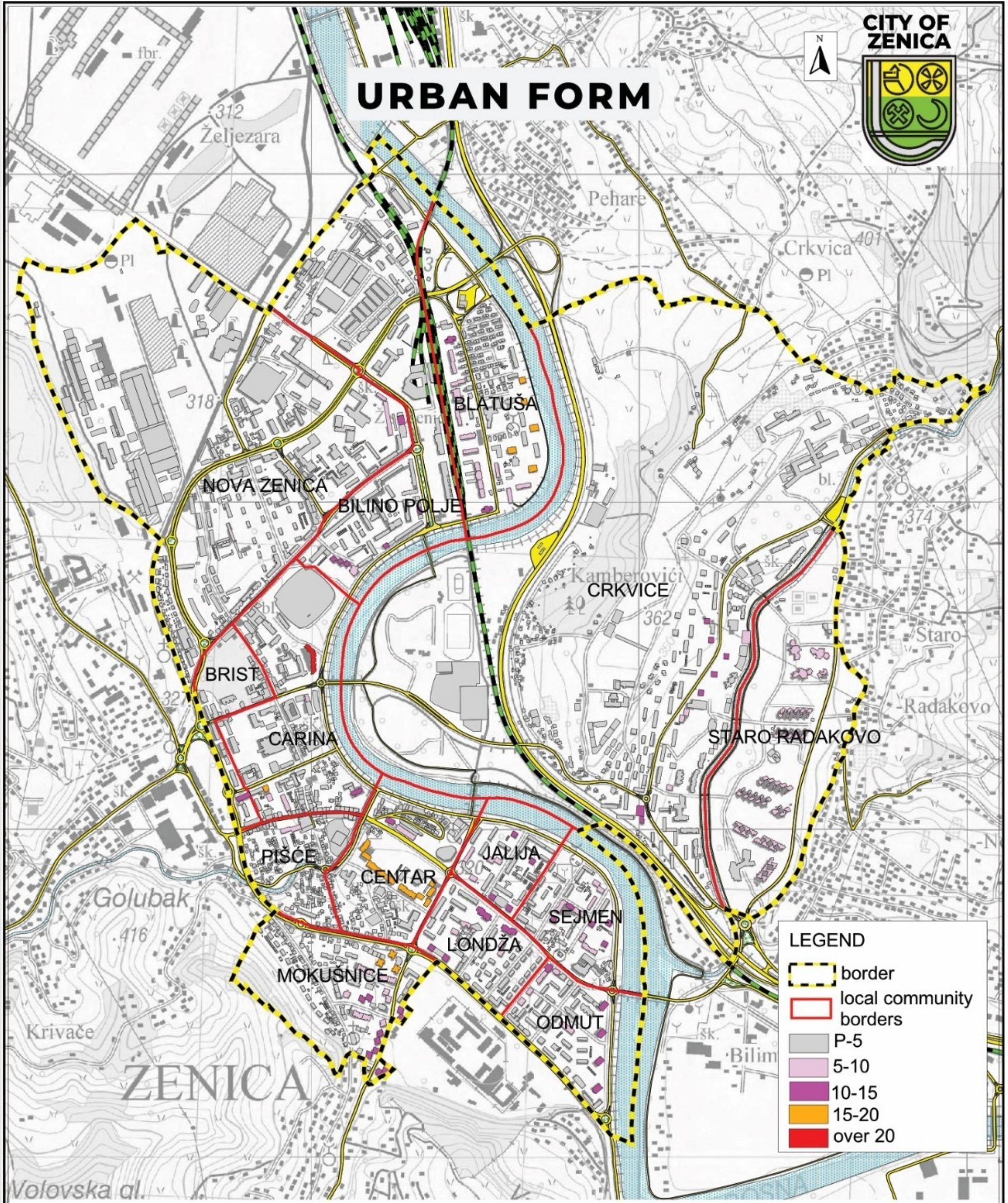
The analysis has included compact urban area consisting of 13 local communities: Bilino polje, Blatuša, Brist, Carina, Centar, Jalija, Londža, Mokušnice, Nova Zenica, Odmut, Pišće, Sejmen and Staro Radakovo. Total surface of analysed area is 464.85 hectares. Data for some of this assessment has been derived from Spatial plan of City of Zenica for period 2016-2036 and Urban plan of City of Zenica for period 2021-2041 which is under preparation process.

Urban morphology/urban form

The city of Zenica underwent several phases of development, closely tied to the growth of the Zenica Ironworks, which was the primary driver of the city's expansion. The first phase, spanning from 1945 to 1955, saw the construction of ground-floor and one-storey homes for factory workers near the Ironworks. The city's first urban plan was adopted in 1950, and during this time, the construction of small residential buildings in the central area began.

From 1965 to 1999, the mass construction of new neighbourhoods, such as Crkvice, Odmut, Centar, Mokušnice and Blatuša, took place, each with a population of around 4,000. The final phase of urban expansion occurred between 1978 and 1984, when the city's urban core expanded southward towards the city's southern entrance. This period saw the development of the Babina Rijeka neighbourhood, which included 1,500 apartments, as well as the construction of collective residential buildings in Radakovo.

In the post-war period, however, there was no systematic construction due to challenges such as the region's terrain and limited available land for development.



LOCAL COMMUNITIES (LC)	SURFACE OF LC (ha)	SURFACE UNDER BUILDING (ha)	GROSS BUILDING PLOT(ha)	PERCANTAGE OFF CONSTRUCTION	CONSTRUCTION ON COEFFICENT
BILINO POLJE	37,29	7,24	17,84	19,42%	0,41
BLATUŠA	27,29	3,06	15,64	11,21%	0,20
BRIST	6,24	1,05	3,90	16,79%	0,27
CARINA	23,71	6,84	19,50	28,85%	0,35
CENTAR	15,24	3,31	16,74	21,74%	0,20
CRKVICE	172,15	12,07	41,04	7,01%	0,29
JALIJA	7,86	1,34	7,10	17,02%	0,19
LONDŽA	9,04	1,90	11,23	21,05%	0,17
MOKUŠNICE	17,29	2,92	14,81	16,87%	0,20
NOVA ZENICA	82,53	17,18	38,23	20,81%	0,45
ODMUT	12,89	1,80	11,84	13,97%	0,15
PIŠĆE	8,66	2,56	5,35	29,56%	0,48
SEJMEN	12,92	1,77	9,33	13,69%	0,19
STARO RADAKOVO	31,59	1,96	11,70	6,21%	0,17

Map 9 Building coverage ratio (BCR)

The map illustrates the more compact urban area and the spatial dimensions of the built structures. The table within the map provides a breakdown of the local communities that make up the coverage. Among them, Crkvice community is the largest, covering 172.15 hectares. This area has a building occupancy rate of 7.01%, with a construction coefficient of 0.29. Based on these parameters, it is evident that the highest building utilization is concentrated in the central part of the coverage, particularly in local communities Centar, Carina, Londža, and Pišće areas. In addition to these spatial details, the map legend also indicates the number of building stories, divided into five categories: buildings with 1-5 floors, 6-10 floors, 10-15 floors, 15-20 floors, and those exceeding 20 floors. Notably, the "Lamela" residential and commercial building is the tallest structure in Zenica, standing at approximately 100 meters. For many years, it held the title of the tallest residential building in Bosnia and Herzegovina.

Floor area ratio (FAR)

No available data

Street canyon aspect ratio

No available data

Green urban spaces and vegetation

The green spaces in Zenica are primarily composed of two main parks: Kamberovića Polje, designed for active recreation, and the Central City Park, intended for passive leisure. Additionally, smaller parks such as Kulina Bana Park and the park on Odmut I contribute to the city's green areas. Urban tree-lined streets, including the Boulevard and several others along major roads, further enhance the city's greenery. The northern part of the city features a green belt, while the Babina Rijeka Recreation Zone offers larger grassy areas, with park development initiated in 2018.

High-traffic locations such as roundabouts, bridges, squares, and pedestrian streets have been landscaped with perennials for long-lasting aesthetic appeal, or seasonal plants that are changed throughout the year. Future plans include the reconstruction of main park areas and tree-lined streets, as well as the creation of larger grassy spaces enriched with ornamental trees and plants to improve both aesthetics and ecological health.

Utility company, ALBA ZENICA ltd., is responsible for maintaining 734,018 m² of lawns, including mowing and weeding. From 2020 to 2024, the city undertook a green space renewal project, restoring 2,829 m² of damaged lawns. Green spaces account for 31.70% of the urban area.

Photo 1. Maintained green spaces within urban city area

Tree canopy coverage

No available data

Permeability of surfaces

The permeability of surfaces in urban areas is a critical factor in managing stormwater, preventing flooding, and addressing the impacts of climate change. In Zenica, the urban landscape is a mixture of built-up land, green spaces, and water areas, each of which contributes differently to the overall permeability of the city. Built-up land, which includes buildings, roads, parking lots, and other asphalted areas, accounts for the largest portion of the urban space, making up 61.85% of analysed total area. These impervious surfaces prevent rainwater from seeping into the soil, leading to increased surface runoff, which can overwhelm drainage systems and lead to flooding. Moreover, the heat retained by these paved areas exacerbates the urban heat island effect, raising temperatures and impacting the city's microclimate.

On the other hand, green spaces, which represent 31.70% of the city, offer a valuable counterbalance by enhancing the permeability of the urban environment. Areas such as Kamberovića Polje, City Park, and residential green belts not only provide recreational spaces but also allow rainwater to infiltrate the soil, replenishing groundwater supplies and reducing the volume of runoff. Expanding and enhancing green spaces through strategies like green roofs, permeable pavements, and rain gardens could significantly improve the city's water absorption capacity and help manage the increasing frequency of heavy rainfall due to climate change.

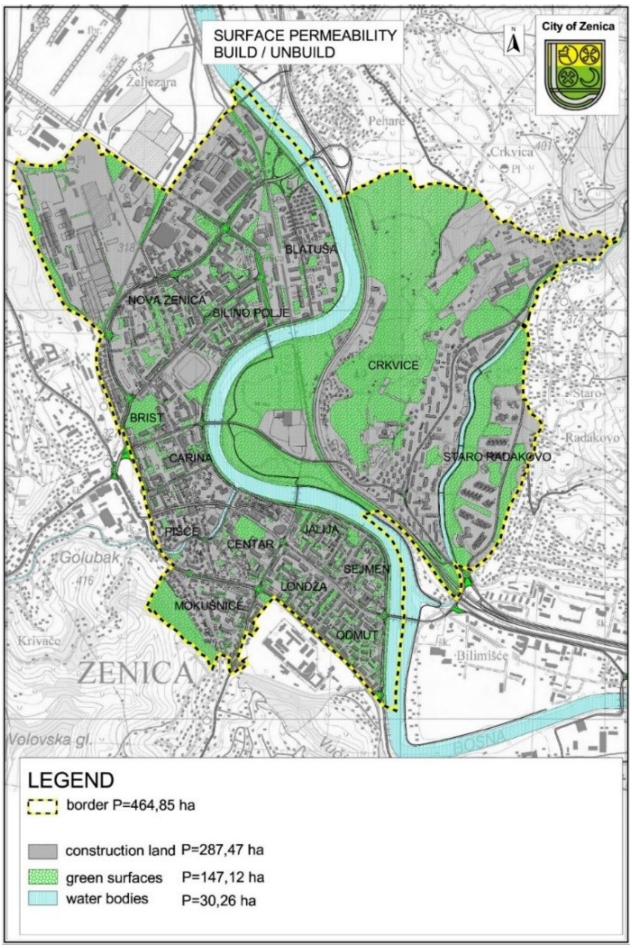
Water areas, including the Bosna River, make up 6.45% of Zenica's land. While water bodies themselves do not contribute directly to surface permeability, they play an essential role in the city's hydrological system by managing water flow and reducing the risk of localized flooding. During heavy rainfalls, the river serves as a natural outlet for excess water, though it too can become overwhelmed if rainfall exceeds its capacity.

As Zenica continues to grow and face the challenges of climate change, understanding the distribution and permeability of different land surfaces is critical for effective urban planning. By enhancing permeability in both built and green areas, Zenica can reduce flood risks, manage stormwater more efficiently, and foster a more sustainable and resilient urban environment.

Share of permeable surfaces related to impermeable surfaces

The map categorizes analysed area into three primary land types: built-up land, green spaces, and water areas. Built-up land, which includes buildings, roads, asphalted areas (such as public spaces and parking lots), constitutes 61.85% of the total area. Green spaces account for 31.70% of the urban area while remaining 6.45% of the area is occupied by water, primarily represented by the Bosna River.

This breakdown provides a clear overview of how the urban space is distributed and highlights the importance of both developed and green areas within the city's structure.

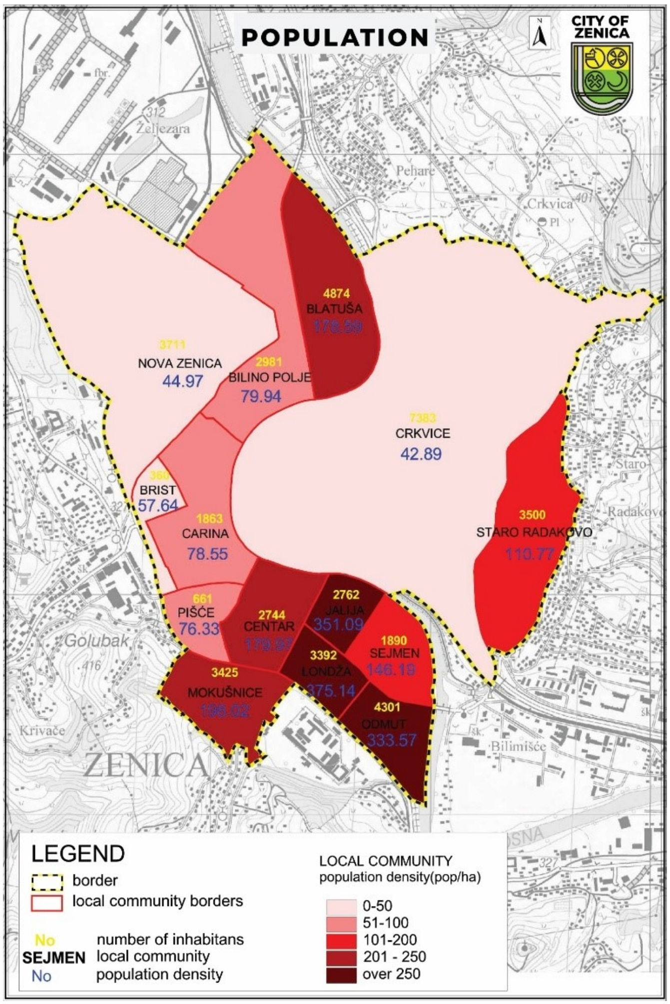


Map 10 Surface Permeability

Population density

In addition to analysing the current situation, we would like to highlight an intriguing phenomenon related to our city. According to the 1879 census, Zenica, during the Austro-Hungarian era, had a population of just 2,000. By the most recent census in 2013, this number had surged to 110,663, reflecting a staggering increase of over 5.433%. When compared to global industrial cities, Zenica stands out for its remarkable demographic growth during this period. Over the observed timeframe, Zenica's population increased 55-fold, while other cities saw more modest growth: Belgrade's population grew 31 times, Zagreb's 25 times, Ljubljana's 11 times, Sarajevo's 13 times, Skopje's 17.5 times, Split's 10 times, and Rijeka's 3 times.

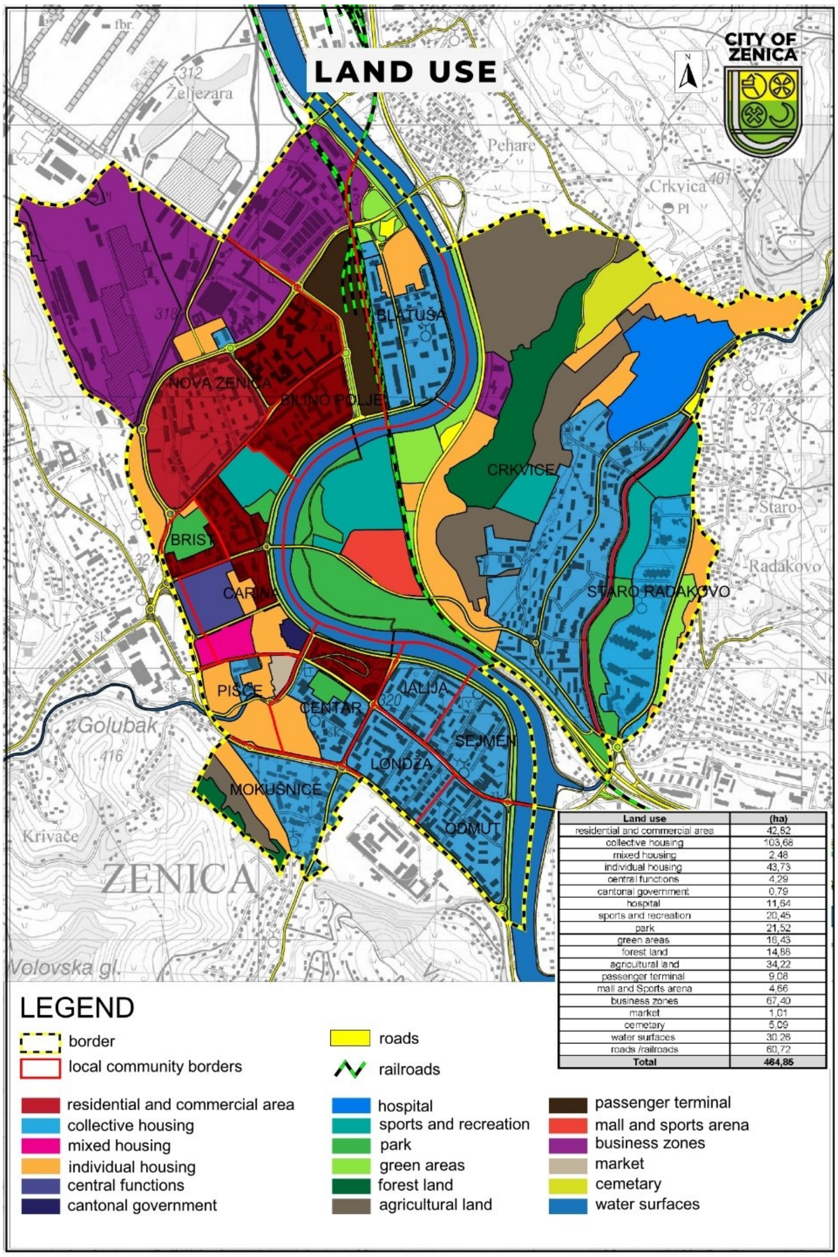
Given that collective housing is concentrated in the city's core, this area has the highest population density, a trend clearly illustrated in the graphic appendix. The average age of Zenica's population is 38.4 years.



Map 11 Population density

Land use

In the urban layout of Zenica, the central area of the city is dominated by Kamberovića Field, a space designated for sports and recreation. Surrounding this central park are residential, business, and collective housing zones. The residential and business zones feature buildings typical of central urban areas. The collective housing zones, built between 1960 and 1980, are characterized by a variety of residential typologies, reflecting different living styles and needs from that era.

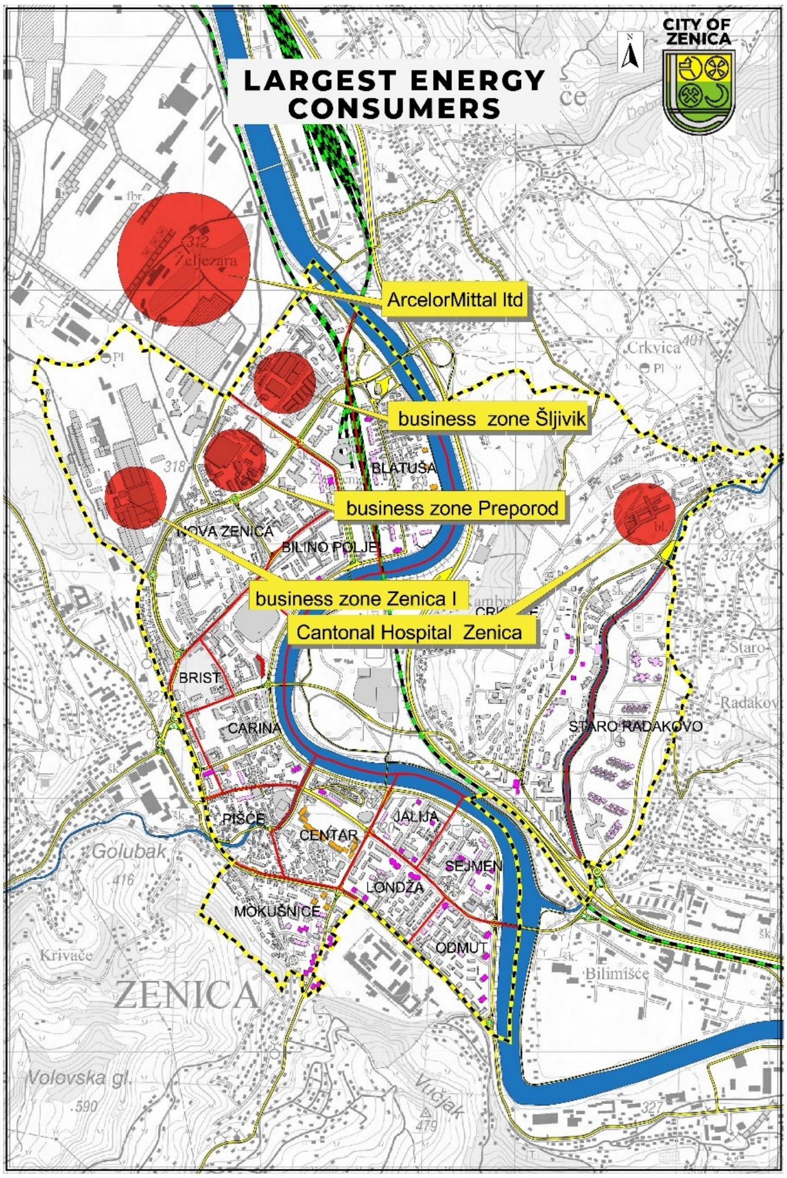


Land use	(ha)
residential and commercial area	42,82
collective housing	103,68
mixed housing	2,48
individual housing	43,73
central functions	4,29
cantonal government	0,79
hospital	11,64
sports and recreation	20,45
park	21,52
green areas	16,43
forest land	14,88
agricultural land	34,22
passenger terminal	9,08
mall and Sports arena	4,66
business zones	67,40
market	1,01
cemetary	5,09
water surfaces	30.26
roads /railroads	60,72
Total	**464,85**

Map 12 Land use

Energy consumption of buildings

The central urban area borders a business zone that includes production facilities, which account for nearly 40% of the city's total urban space. ArcelorMittal occupies the largest portion of this zone and is also the city's largest electricity consumer. In addition to this industrial zone, there are other key business areas, including Business Zone Zenica I, Business Zone Šljivik, and Business Zone Preporod. It's also important to highlight the Cantonal Hospital, which, due to its size and function, is another significant consumer of resources in the city.



Map 13 Energy consumption private sector

Energy consumption of transportation

No available data

SENSITIVITY OF EQUIPMENT AND MATERIALS

The City of Zenica has undergone significant urban development, particularly in its residential and industrial zones, which have a direct impact on the sensitivity of materials and equipment to environmental conditions. The assessment of material sensitivity focuses on factors such as thermal conductivity, heat capacity, surface temperature, reflectivity (Albedo coefficient), and material durability.

Construction Materials

The extensive construction of collective housing between 1965 and 1984 heavily influenced Zenica's urban landscape. Predominantly, **concrete and asbestos materials** were used in residential areas, with flat roofs for taller buildings and sloped roofs for smaller structures. Due to the hazardous effects of asbestos roofing, the City of Zenica co-finances annual roof replacements to improve safety and environmental standards.

Industrial zones, especially around the **Ironworks (ArcelorMittal)**, are characterized by **metal structures**, while contemporary buildings incorporate **prefabricated reinforced concrete** and **thermal insulation panels** to enhance energy efficiency.

Surface Temperature and Thermal Conductivity

No specific data is available for surface temperature variations across the city. However, the use of materials such as concrete, asphalt, and metal contributes to heat accumulation, particularly in densely built-up areas.

The business and industrial zones, being major energy consumers, further increase localized temperatures, impacting both the microclimate and energy efficiency.

Material Condition and Durability

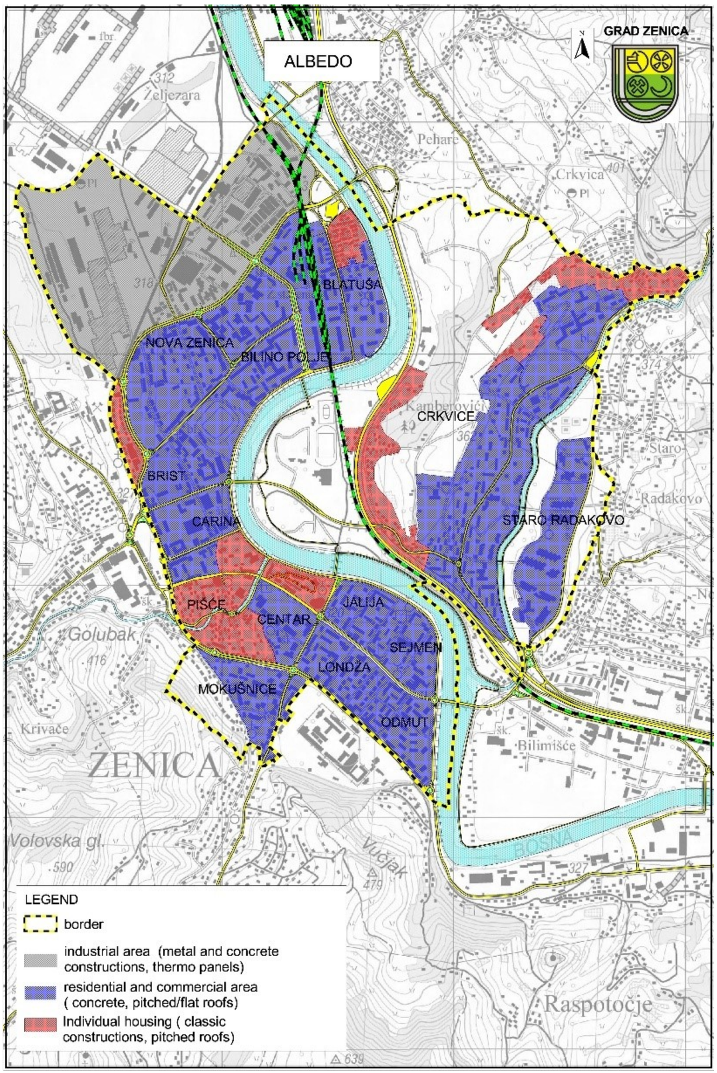
Many older buildings in Zenica still rely on aging materials, which may be susceptible to degradation due to temperature fluctuations, air pollution, and precipitation patterns.

Renovation efforts, particularly the replacement of asbestos roofing and implementation of energy-efficient insulation, are key priorities for improving material resilience.

Albedo (Reflectivity) Coefficient

The intensive construction of collective housing settlements between 1965 and 1984 greatly influenced the city's residential and residential-business zones, which are marked in blue. This period saw the widespread use of concrete as a building material. The taller buildings feature flat roofs, while the lower buildings typically have sloping roofs covered with tiles or asbestos. Due to the harmful effects of asbestos roofing, the City of Zenica annually co-finances efforts to replace these roofs. The areas with individual residential buildings are marked red.

In the business zones, particularly around the Ironworks, construction is characterized by metal structures. Today, most buildings in these business zones are constructed using prefabricated reinforced concrete structures, often with thermal panel cladding for better insulation.



Map 14 Albedo Coefficient

Thermal Conductivity

No available data

Heat Capacity

No available data

Surface Temperature

No available data

Emissivity

No available data

Coverage Area

No available data

Vegetative Cover

No available data

VULNERABLE GROUPS

Socio – economic indicators

Table 5. Socio-economic indicators for City of Zenica

SOCIO ECONOMIC INDICATORS											
Indicators/ Years	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Young people (15-64)	87.280	87.892	87.779	77.938	77.289	76.546	75.852	74.872	73.966	73.126	72.449
Elderly people (65+)	18.880	19.161	19.137	11.212	15.195	15.740	16.315	17.039	17.198	17.480	18.119
Poverty rate	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Unemployment rate	48,00	48,20	48,30	47,30	45,20	42,30	40,40	40,90	40,10	38,20	38,00
Male	54.653	54.587	54.435	54.350	54.185	54.099	54.046	53.923	53.477	53.178	53.016
Female	56.041	55.875	55.775	55.600	55.494	55.344	55.277	55.170	54.801	54.527	54.359
Immigrated people	604	637	n/a	n/a	532	561	603	529	574	570	531
Low-skilled jobs	8.367	8.049	6.833	6.975	7.028	n/a	n/a	n/a	n/a	n/a	n/a
Social housing	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Density of population	227,70	227,50	227,20	196,90	196,40	196,00	195,70	195,30	193,90	192,80	192,30
Retired people	20.929	21.291	21.485	21.698	21.810	21.974	21.898	21.869	21.619	21.390	21.679

Source: Federal Institute of Statistics

Demographic Changes

The number of young people (15-64 years old) shows a declining trend, from 87,280 in 2013 to 72,449 in 2023. This decline can be linked to population migration and negative natural growth. At the same time, the number of elderly people (65+) is gradually increasing, indicating an aging population.

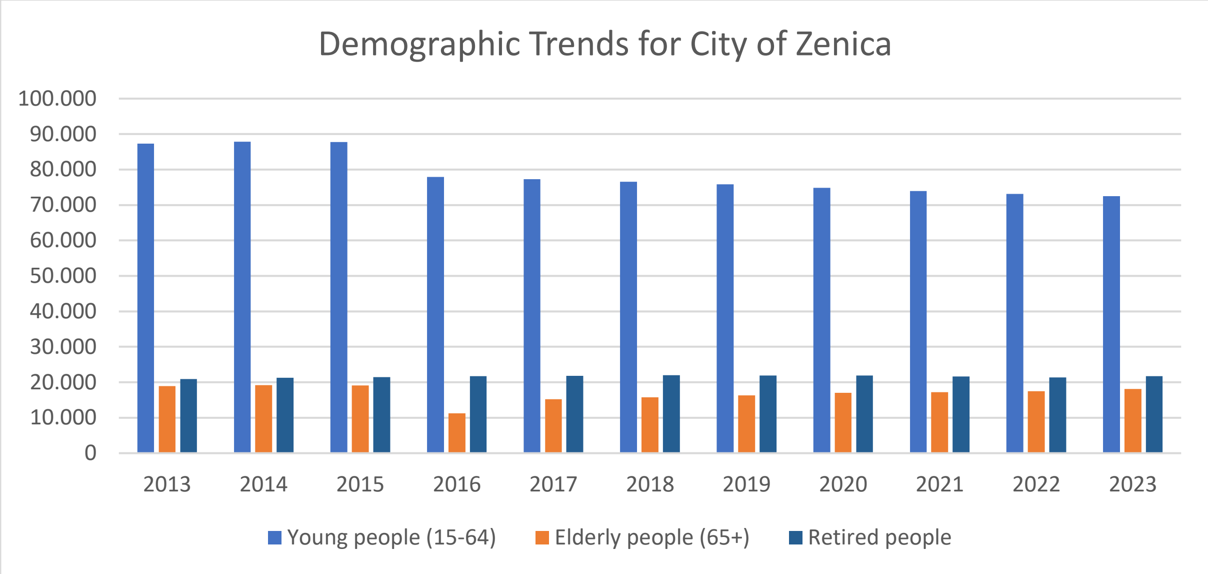


Diagram 2. Demographic Trends for City of Zenica

(https://fzs.ba/wp-content/uploads/2024/06/zenicko-dobojski.pdf)

Unemployment Rate

Table 6. Unemployment rate for City of Zenica

Unemployment rate	
Year	Index
2013	48,00
2014	48,20
2015	48,30
2016	47,30
2017	45,20
2018	42,30
2019	40,40
2020	40,90
2021	40,10
2022	38,20
2023	38,00

Source:Federal Institute for Development Programming ((https://fzzpr.gov.ba/files/Socioekonomski%20pokazatelji%20po%20op%C4%87inama/Socioekonomski%20pokazatelji%202023.pdf)

The City of Zenica has experienced a gradual decline in its unemployment rate over the past decade. In 2013, the unemployment rate stood at 48.00%, reflecting significant economic challenges. Over the following years, there was a slow but steady improvement. By 2017, the rate had decreased to 45.20%, and by 2019, it had further dropped to 40.40%.

Despite a slight increase in 2020, likely due to the global economic impact of the COVID-19 pandemic, the downward trend resumed in the following years. By 2022, the unemployment rate had fallen to 38.20%, reaching 38.00% in 2023. These figures indicate positive economic progress in Zenica, driven by business development, investments, and workforce initiatives aimed at reducing unemployment. However, continued efforts are necessary to sustain and accelerate this trend for long-term economic stability and job creation in the city.

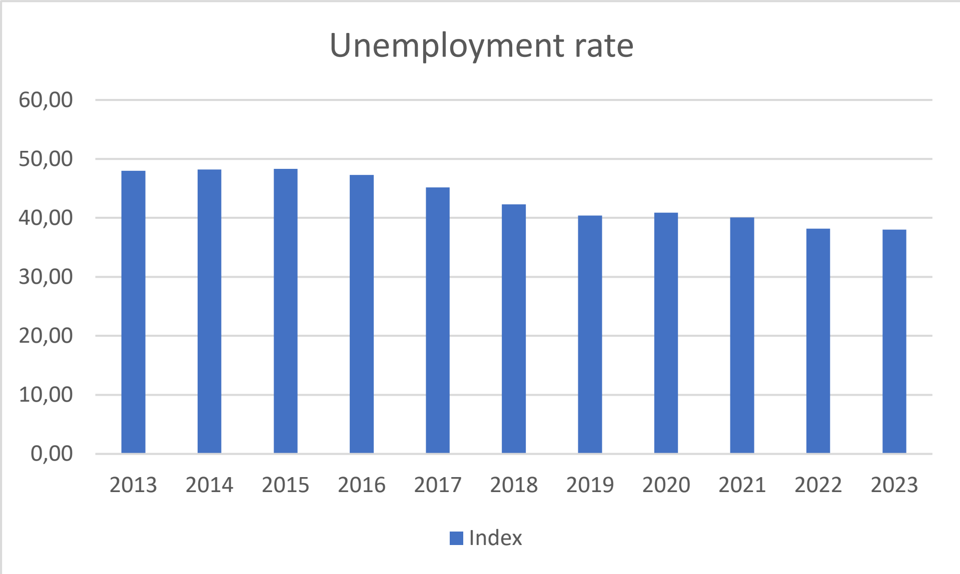


Diagram 3. Unemployment rate Trends for City of Zenica
(https://fzzpr.gov.ba/files/Socioekonomski%20pokazatelji%20po%20op%C4%87inama/Socioekonomski%20pokazatelji%202023.pdf)

Migration and Population

The number of immigrated people varies over the years, with the highest recorded in 2014 (637 people), while in 2023, this number dropped to 531. Population density is also decreasing, further confirming population decline.

The data in the table highlights significant demographic challenges in Zenica, including a reduction in the working-age population and an increase in the elderly population. At the same time, improvements in the unemployment rate indicate a positive economic trend, but further efforts are needed to strengthen the labor market and encourage economic development. Additionally, health challenges such as cardiovascular diseases, malignant diseases, metabolic disorders, violent deaths, and respiratory diseases remain crucial areas of concern that require strategic planning and healthcare improvements. Addressing these issues through better healthcare policies, economic opportunities, and social programs will be essential to ensuring a sustainable and prosperous future for the city and its residents.

Furthermore, a comprehensive approach to tackling these issues requires collaboration between governmental institutions, private sector stakeholders, and the local community. Investment in healthcare infrastructure, employment initiatives, and education programs can help mitigate some of the negative trends observed. Encouraging youth retention through improved job opportunities and social benefits will be crucial in slowing the population decline and ensuring long-term economic stability.

Likewise, efforts to enhance the quality of life for the elderly population, such as better healthcare access and social inclusion programs, can contribute to a more balanced demographic structure. In the coming years, strategic policy interventions and targeted investments will play a vital role in shaping Zenica's economic and social future, making it a more resilient and thriving city for generations to come.

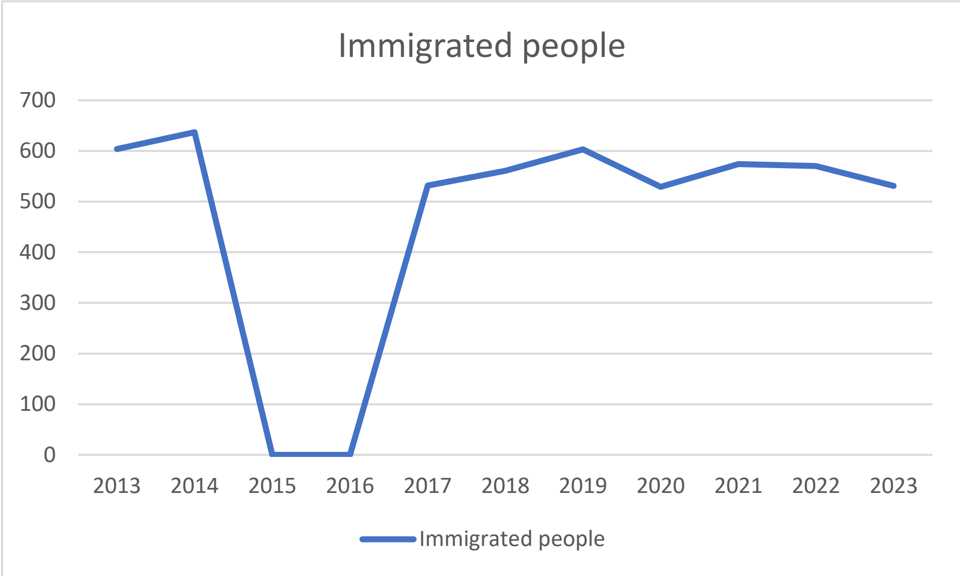


Diagram 4. Immigrated people Trends for City of Zenica (https://docs.google.com/gview?url=http://fzs.ba/wp-content/uploads/2024/06/Demografska-statistika.pdf)

Density of population

Table 7. Density od population for City of Zenica

Year	Index
2013	227,7
2014	227,5
2015	227,2
2016	196,9
2017	196,4
2018	196
2019	195,7
2020	195,3
2021	193,9
2022	192,8
2023	192,3 0

Source: 6. Federal Institute for Development Programming (https://fzzpr.gov.ba/files/Socioekonomski%20pokazatelji%20po%20op%C4%87inama/Socioekonomski%20pokazatelji%202023.pdf)

The population density in City of Zenica has been gradually decreasing over the past decade, reflecting demographic changes and migration trends. In 2013, the city had a population density of 227.7 inhabitants per square kilometre. However, a significant decline occurred in 2016, when the density dropped to 196.9, likely due to population movement and socio-economic factors.

Since then, the downward trend has continued, with the population density reaching 192.3 inhabitants per square kilometre in 2023. This steady decline suggests a combination of factors, including emigration, lower birth rates, and potential shifts in urban development. These demographic trends highlight the need for strategic planning to address population retention, economic opportunities, and urban sustainability in Zenica.

Retired people

The number of retired people in City of Zenica has shown a steady increase over the past decade, reflecting broader demographic and economic trends.

In 2013, the number of retirees stood at 20,929, gradually rising each year and peaking at 21,974 in 2018. This steady growth indicates an aging population and possibly improved access to pension benefits. However, after 2018, the trend became more fluctuating, with slight decreases in certain years. By 2021, the number of retirees had declined to 21,619, reaching its lowest point in recent years in 2022 with 21,390. In 2023, the number slightly rebounded to 21,679, suggesting stabilization.

These figures highlight important social and economic aspects for Zenica, including the need for sustainable pension funds, healthcare services for the elderly, and policies to support aging citizens. Understanding these trends can help local authorities and businesses better plan, ensuring a stable and supportive environment for retirees.

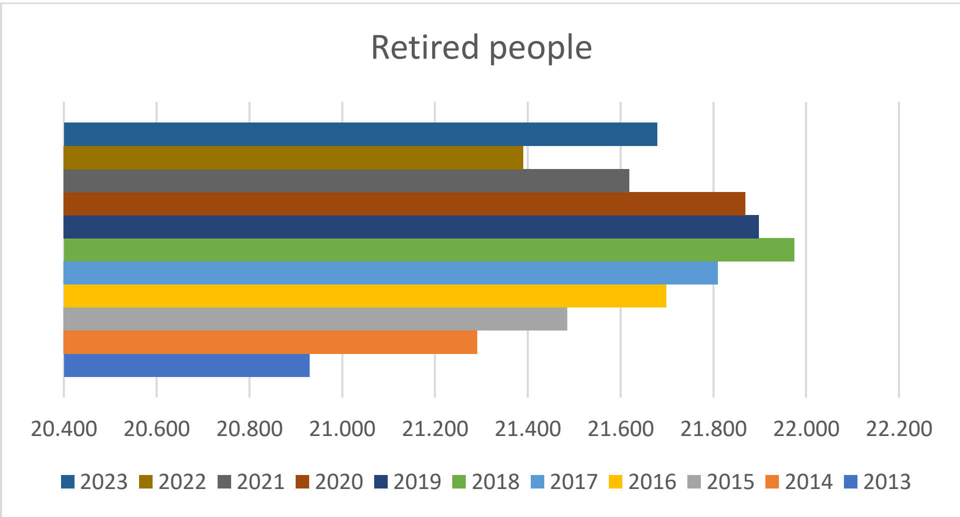


Diagram 5. Retired people Trends for City of Zenica
(https://fzzpr.gov.ba/files/Socioekonomski%20pokazatelji%20po%20op%C4%87inama/Socioekonomski%20pokazatelji%202023.pdf)

Health conditions

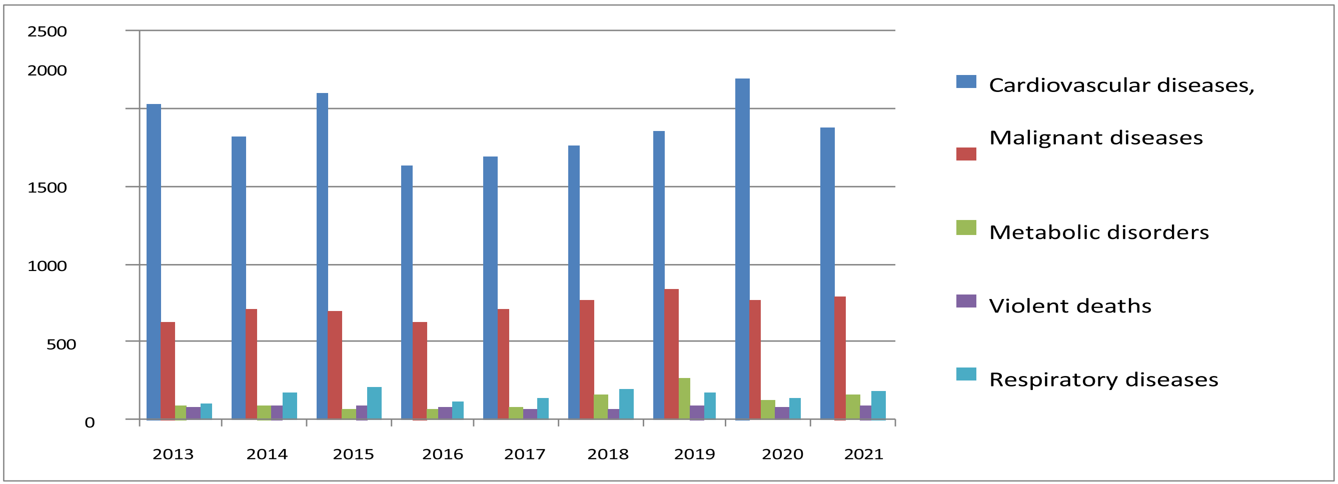


Diagram 6. Trend of diseases for the City of Zenica

Source: Institute for Health and Food Safety Zenica (https://inz.ba/wp-content/uploads/2023/12/Informacija-o-zdravstvenom-stanju-2021.pdf)

Ill people

This number (57.129) represents individuals suffering from various illnesses, without specifying the type. It indicates a significant portion of the population facing health challenges, suggesting a need for a well-developed healthcare system to address the different types of diseases and medical needs.

Disabled people

Although smaller (3.063) than the number of ill people, this figure highlights a substantial portion of the population that requires specialized care and support. Disabilities can range from physical to mental, or a combination of both, and these individuals often need rehabilitative services and social support to maintain a decent quality of life.

Mentally ill people

Mental health conditions are a critical concern and can vary in severity, from mild to severe forms. With 3,387 mentally ill individuals in this dataset, it suggests that mental illness is a significant issue and that investment in mental health care, prevention, and social integration is necessary to address these needs.

Mortality rate

A mortality rate of 10.5% means that approximately 1 in 10 individuals within this group die. This is a relatively high rate, indicating serious health challenges among the ill and disabled populations. It points to the need for improved healthcare systems, early diagnosis, and better treatment to reduce preventable deaths.

Hospitals capacity

The Cantonal Hospital Zenica provides secondary and tertiary healthcare services for the residents of the Zenica-Doboj Canton, with a capacity of approximately 900 beds.

Health centers

In the primary healthcare sector, in health centres and regional clinics across the City of Zenica, there are 125 doctors and 255 medical technicians, with healthcare coverage supported by 7 emergency vehicles (2024). Primary healthcare is provided in 27 family medicine clinics located throughout the City of Zenica. The Health Center "Dom zdravlja" Zenica offers patients accessible and efficient healthcare services based on modern medical advancements, with a daily commitment to improving service quality and availability. Annually, the Health Center "Dom zdravlja" Zenica performs approximately 1,300,000 healthcare services.

Retirement houses

The Pensioners' Home with a stationary unit located in the City of Zenica has a capacity of 170 residents, with accommodation costs ranging from 1,200 to 1,240 BAM. The facilities are fully occupied.

Social housing

Accommodation in social protection institutions in the City of Zenica during 2022 was provided for 26 children and 186 adults. Specific data on the number of social housing units and allocation criteria are not available.

Summary

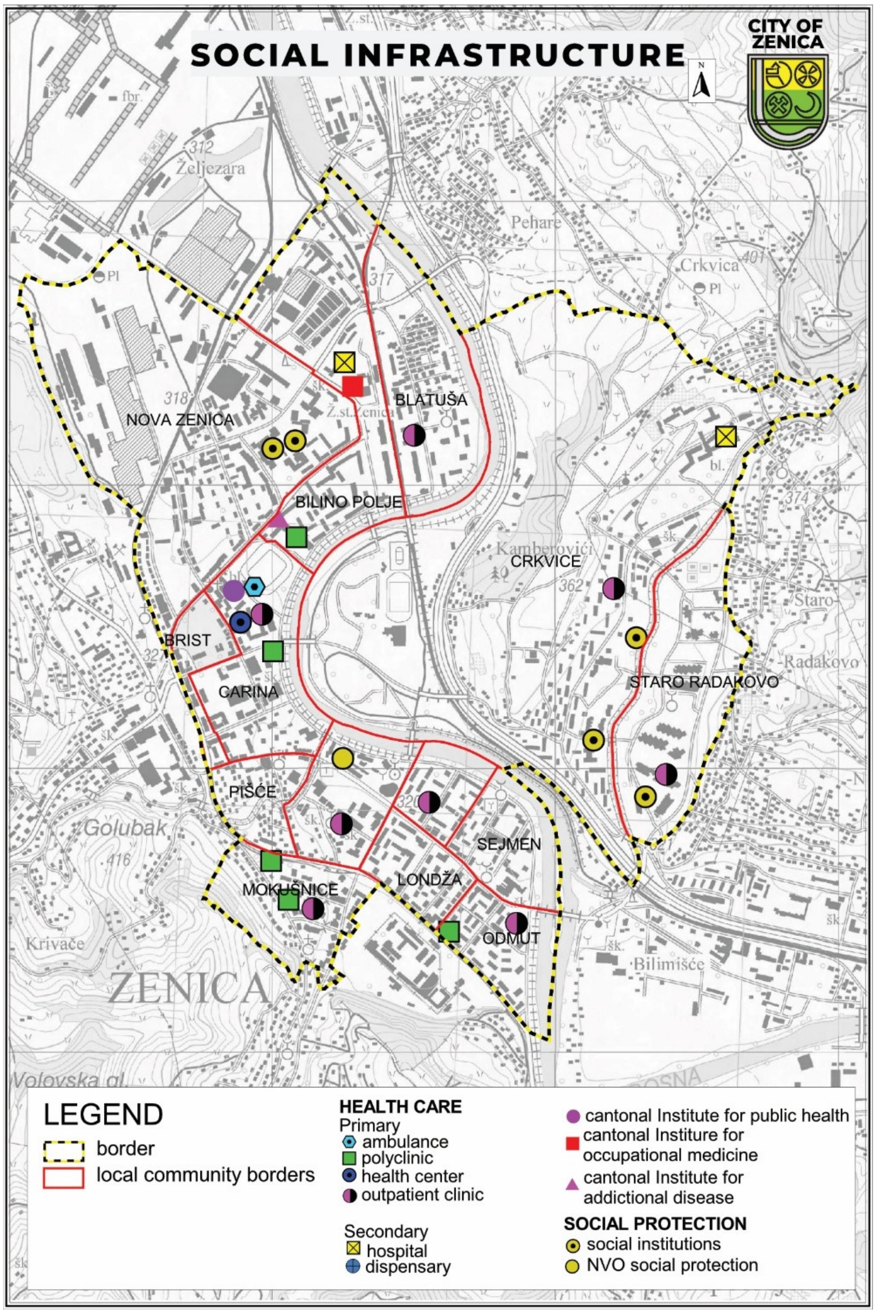
The data shows a substantial portion of the population dealing with health and social issues, including both physical and mental disabilities. The mortality rate being relatively high highlights the urgent need for an enhanced healthcare infrastructure focused on prevention, early detection, and comprehensive treatment. Special attention should be given to mental health and the integration of disabled individuals into society with adequate support and rehabilitation services.

In primary healthcare in the City of Zenica, a total of 57,129 diseases were registered in 2022, which equals 5,593 diseases per 10,000 insured individuals. Among children aged 0-4 years, 8,813 diseases were registered, or 1,799 diseases per 1,000 insured individuals in this age group. Among school-age children and adolescents, 5,763 diseases were registered, or 440 diseases per 1,000 insured individuals in this group.

In 2022, a total of 36,281 diseases were registered among the adult population, which is 612 diseases per 1,000 insured individuals in this group. Among the population over the age of 65, 15,031 diseases were registered, or 651 diseases per 1,000 individuals insured in this group.

In 2022, primary healthcare services in the City of Zenica were provided by a total of 109 medical doctors, 21 dentists, and 256 healthcare technicians.

In primary healthcare, there is one doctor for every 988 residents, one dentist for every 5,129 residents, and one healthcare technician for every 421 residents.



Map 15 Social Infrastructure

Conclusion

In conclusion, the process of collecting data for socio-economic indicators at the City of Zenica level proved to be challenging due to several factors, primarily the lack of detailed data by city zones. Although official yearbooks and sources such as the Federal Bureau of Statistics and the Federal Bureau of Programming were utilized, the data collected were mostly aggregated at a higher level, offering limited insight into specific urban zones. These sources, while reliable and comprehensive, did not provide the necessary granularity to analyse socio-economic conditions within city zones. While the yearbooks and statistical reports offered valuable insights into demographic and economic trends, they did not provide data that would allow for deeper analysis at the zone level.

Moreover, despite efforts to obtain the most accurate picture, gathering data on specific indicators such as poverty, social housing, or migration by zone proved difficult. These challenges highlight the need for qualitative approaches, such as interviews, surveys, and collaboration with local communities, to gather data that is not available through official sources. As quantitative data at the micro level were not systematically collected, these alternative methods are essential.

Moving forward, when developing the local action plan that will focus on specific city zones, we will have to use a qualitative approach. This will allow us to gather the insights and data needed to better understand the local socio-economic conditions at the specific zone, offering a more detailed and accurate picture for effective planning and decision-making.

Vulnerability Index

No available data

PREPAREDNESS AND ADAPTIVE CAPACITY OF CITIES AND MUNICIPALITIES

The "Risk Assessment of Natural and Other Disasters in the City of Zenica" is a fundamental document that serves as the basis for developing the Protection and Rescue Plan and the Development Program for Protection and Rescue. It is prepared in accordance with legal frameworks and methodologies established by the Federation of Bosnia and Herzegovina.

A major focus is on identifying potential threats, categorized into natural disasters (earthquakes, floods, landslides, extreme weather conditions), technical and technological hazards (industrial accidents, hazardous material spills, fires), and other emergencies (traffic accidents, mining incidents, and environmental pollution). Each risk is assessed based on its likelihood, potential consequences, and the city's ability to respond effectively.

The document also evaluates the preparedness of civil protection forces, their organization, equipment, and training levels. It outlines necessary preventive measures, emergency response protocols, and financial requirements for effective disaster management. The final sections provide strategic recommendations for improving disaster resilience, including public awareness initiatives, collaboration with non-governmental organizations, and the integration of private sector resources into emergency response efforts.

This assessment plays a critical role in urban planning and risk management, ensuring that Zenica is better prepared for potential disasters and can minimize harm to its residents and infrastructure.

Risk Matrix

Risk Matrix is a structured approach used to assess and categorize risks based on their probability of occurrence and potential consequences. This methodology helps identify and prioritize significant risks requiring strategic planning and response measures.

Risk Assessment and Classification

The risk assessment table categorizes potential threats based on two key criteria:

1. **Consequences (Severity of Impact)** – Ranging from **catastrophic** (5) to **negligible** (1).
2. **Likelihood (Probability of Occurrence)** – Ranging from **extremely low** (1) to **extremely high** (5).

Findings:

- **Floods (B), industrial accidents (F), and epidemics/pandemics (D)** are classified as moderate to significant risks, meaning they require serious attention in terms of preparedness.
- **Extreme temperatures (C) and accidents at landfills (E**) are considered **moderate risks**, highlighting their potential to cause disruption.
- **Earthquakes (A)** and **accidents involving hazardous materials (G)**, while present, seem to have a lower likelihood but still demand preparedness due to their potential consequences.

This classification helps prioritize where resources and response efforts should be focused.

Application in Zenica: The document applies this framework to various hazards such as earthquakes, floods, landslides, industrial accidents, and pollution. The matrix helps local authorities identify the most critical risks and allocate resources accordingly.

Table 8. Risk Assessment and Classification

Consequences	5- catastrophic					
	4 - significant			**B**		
	3 – moderate		**E**	**D**	**F**	
	2 – minor	**G**	**A**	**C**		
	1 - negligible					
		1.extremely low	2. low	3. moderate	4. high	5. extremely high
		Vjerojatnosti				

Potential Risks:
A. Earthquake
B. Flood
C. Extreme Temperatures
D. Epidemics and Pandemics
E. Accidents at Landfills
F. Industrial Accidents
G. Accidents in Transport of Hazardous Materials

(red)	Very High Risk
(orange)	High Risk
(yellow)	Moderate Risk
(green)	Low Risk

Some of the key identified risks in the City of Zenica include:

- **Natural Disasters:** Earthquakes, floods, landslides, droughts, **extreme temperatures**, strong winds, and heavy snowfall.
- **Technical and Technological Hazards:** Industrial accidents, gas explosions, fires, and traffic accidents.
- **Environmental Risks:** Air pollution, contamination of water sources, and soil degradation.
- **Biological and Health-Related Threats:** Epidemics, zoonoses (animal diseases), and plant diseases.

Each type of threat is assessed based on probability, potential damage, and preparedness levels, ensuring a structured approach to disaster risk reduction.

Readiness of Operational Capacities

The readiness of operational capacities in Zenica is assessed based on the availability, coordination, and efficiency of emergency response units. The document highlights key factors influencing preparedness:

Table 9. Summary overview of Readiness of Operational Capacities

Operational Forces	Civil Protection				Firefighting				Mountain Rescue Service (GSS)				Water and Underwater Rescue Service (ISS)				Rescue Service from Rubble			
*Kriteriji	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
1.			X				X			X				X				X		
2.			X				X				X				X				X	
3.			X				X				X				X			X		
4.			X				X				X				X			X		
5.			X				X				X				X				X	
6.			X				X				X				X				X	
7.			X				X				X				X				X	
Ukupno																				

*Criteria for Operational Capacity Readiness:

1. Personnel Staffing Levels
2. Readiness of Command Personnel
3. Training and Qualification of Both Personnel and Command Staff
4. Drilled and Practiced Readiness
5. Availability of Material Resources and Equipment
6. Mobilization Readiness/Operational Readiness Time
7. Self-Sufficiency and Logistical Resilience

4	Very Low Readiness
3	Low Readiness
2	High Readiness
1	Very High Readiness

Equipment and Personnel

- **Firefighting brigades** for industrial and urban fire suppression.
- **Medical emergency teams** for rapid response to health crises and injury treatment.
- **Search and rescue units** for urban, water, and mountain rescue operations.

- **Technical response teams** for hazardous material spills and infrastructure damage control.
- Some areas experience a **shortage of modern equipment**, requiring upgrades to firefighting gear, medical supplies, and flood protection infrastructure.

Coordination Mechanisms

- **Inter-agency collaboration:** The Civil Protection System works with municipal services, hospitals, police, and private-sector industries to ensure a coordinated emergency response.
- **Crisis management structure:** The city has an Emergency Operations Centre (EOC), responsible for decision-making and resource allocation during disasters.
- **Legislative framework:** The system operates under local and national disaster response laws, which regulate emergency procedures and financial aid allocation.

The Civil Protection and Firefighting units show varying levels of preparedness across different evaluation criteria.

There are gaps in command readiness and operational efficiency, particularly in response to large-scale threats like floods and industrial accidents.

Some teams lack essential training and logistical resilience, suggesting a need for investment in drills, staffing, and equipment.

Relationship Between the Civil Protection System and Threats/Risks

Earthquakes, floods, and industrial accidents show a low to moderate level of readiness, which is concerning given their potential impact.

Extreme temperatures and pandemics have gaps in operational response, indicating a need for improved preparedness, particularly in health and environmental resilience.

Emergency communication systems need enhancement to improve coordination between agencies.

Table 10. Relationship Between the Civil Protection System and Threats/Risks

Elements for the Analysis of Civil Protection in the Response Area	Readiness of Responsible and Management Capacities				Readiness of Operational Capacities				Mobility Status of Civil Protection System's Operational Capacities and Communication Capabilities				**Conclusion**			
Threat	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
A. Earthquake			X				X				X				X	
B. Flood			X				X				X				X	

C. Extreme Temperatures			X			X				X				X		
D. Epidemics and Pandemics			X			X					X			X		
E. Accidents at Waste Disposal Sites			X				X				X				X	
F. Industrial Accidents			X				X				X				X	
G. Accidents in Transport of Hazardous Materials			X				X				X				X	

4	Very Low Readiness
3	Low Readiness
2	High Readiness
1	Very High Readiness

1. Prevention and Preparedness

- Risk monitoring and early warning systems.
- Public education and awareness campaigns.
- Urban planning and infrastructure reinforcement to reduce vulnerability.
- **Flood Prevention:** Strengthening river embankments, improving drainage systems, and restricting illegal construction in flood-prone areas.
- **Landslide Mitigation:** Monitoring and stabilizing slopes, restricting deforestation, and regulating construction on unstable terrain.
- **Air Pollution Control:** Implementing stricter environmental regulations for industries and encouraging the transition to cleaner energy sources.

2. Emergency Response and Rescue

- Immediate activation of emergency teams.
- Evacuation and first aid operations.
- Coordination with police, fire brigades, and medical services.
- **Sector-Specific Responses:**
    - **Floods:** Deployment of sandbags, evacuation plans, and water rescue units.
    - **Industrial Accidents:** Hazardous material containment teams and emergency medical response.
    - **Health Crises:** Coordination with healthcare providers for epidemic management.
    - **Earthquakes:** Search and rescue operations and structural damage assessments.

3. Recovery and Rehabilitation

- Infrastructure repair and reconstruction.
- Environmental restoration and contamination control.
- Financial assistance and social support for affected populations.

The system relies on cooperation with local, cantonal, and state-level institutions, as well as international partners and non-governmental organizations (NGOs). The main challenges include enhancing the speed of response, securing additional funding, and upgrading existing disaster response infrastructure.

5. Conclusions

The UHI Risk and Vulnerability Assessment for a selected city zone in the City of Zenica was conducted to test the methodology and tools. Collected data suggests that Zenica is increasingly vulnerable to the impacts of climate change, with the temperature rises and changes in precipitation patterns aligning with global climate trends. Adaptation strategies will be crucial to mitigate these impacts and build resilience against the growing number of hot days, extreme temperature fluctuations, and potential drought conditions.

The urban heat island (UHI) effect in Zenica is influenced by its built environment and the distribution of green spaces, with significant implications for temperature fluctuations and the city's climate resilience. Covering 464.85 hectares, analysed urban area is primarily composed of impervious surfaces, including roads, parking lots, and buildings, which make up 61.85% of the space. These surfaces absorb and retain heat, exacerbating the UHI effect by raising temperatures in the city, especially in the denser, more compact neighbourhoods near the city center, where population density is highest.

In contrast, Zenica's green spaces, which occupy 31.70% of the urban area, help mitigate the UHI effect by offering natural cooling and improving the city's microclimate. Parks like Kamberovića Polje and the Central City Park, along with tree-lined streets and green belts, not only provide recreational spaces but also enhance the permeability of the urban environment, allowing rainwater to infiltrate the soil and reducing runoff. These green areas are crucial for managing the city's stormwater and reducing the risk of flooding, which can be exacerbated by the increased surface runoff from impervious areas. However, the rapid urban expansion and high proportion of built-up land in Zenica highlight the need for further development of green infrastructure to better combat UHI and enhance the city's resilience to climate change.

The city's mixed land use, including residential, business, and industrial zones, contributes further to the UHI effect, particularly in areas close to industrial facilities like ArcelorMittal, the city's largest electricity consumer. These zones are characterized by high energy consumption and elevated heat production. To effectively tackle the challenges posed by the UHI effect, Zenica's future urban planning must prioritize expanding green spaces, improving surface permeability, and integrating sustainable design features to reduce heat retention, manage stormwater, and foster a more climate-resilient urban environment.

The "Risk Assessment of Natural and Other Disasters in the City of Zenica" serves as a crucial foundation for the city's disaster preparedness and response planning. It categorizes risks into natural disasters (earthquakes, floods, landslides, extreme weather), technological hazards (industrial accidents, hazardous material spills), and other emergencies (traffic accidents, mining incidents, environmental pollution). This document plays a vital role in urban planning, guiding the development of response protocols, preventive measures, and strategic recommendations for improving disaster resilience. It stresses the importance of public awareness, collaboration with NGOs, and integrating private sector resources into emergency responses. By assessing and categorizing risks based on severity and likelihood, the document ensures Zenica is better equipped to minimize damage and protect its residents and infrastructure from potential disasters.

6. References

1. Federal Hydrometeorological Institute; Weather Almanac, Annual analysis (2023) https://www.fhmzbih.gov.ba/latinica/KLIMA/godisnjaci.php
2. Development Strategy of City of Zenica for period 2023-2027, Situational Analysis
3. Risk Assessment of Natural and Other Disasters in the City of Zenica, 2023
4. Spatial Plan of City of Zenica for period 2016-2036; https://stage.zenica.ba/sluzbe/sluzba-za-urbanizam/planska-dokumentacija/
5. Federal Bureau of Statistics- https://fzs.ba/
6. Federal Institute for Development Programming - https://www.fzzpr.gov.ba/

Annexes

ANNEX A - Summary of a survey assessing the adaptation capacity of the City of Zenica to disaster risk management and climate change

An anonymous survey was conducted to assess the city's adaptability to disaster risk management and climate change. The results obtained have been used exclusively for the development of the "Urban Heat Islands Vulnerability and Risk Assessment."

The results of the assessment are as follows:

Evaluation Scale

1 = Not established, does not exist in the system

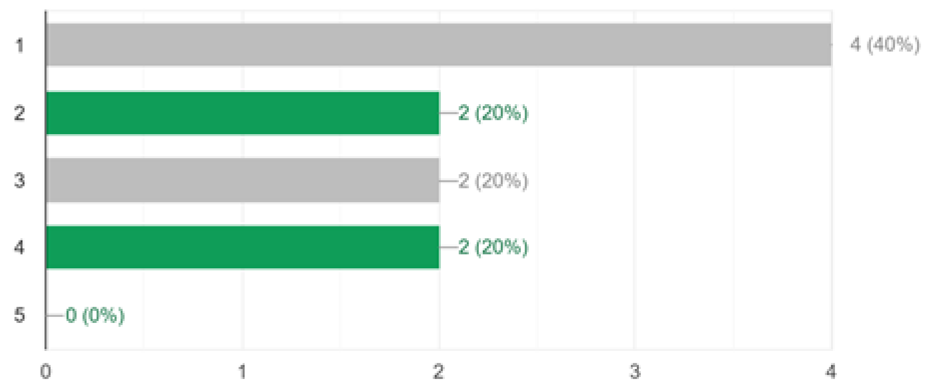
2 = Low level of establishment/equipment/preparedness

3 = Average level of establishment/equipment/preparedness

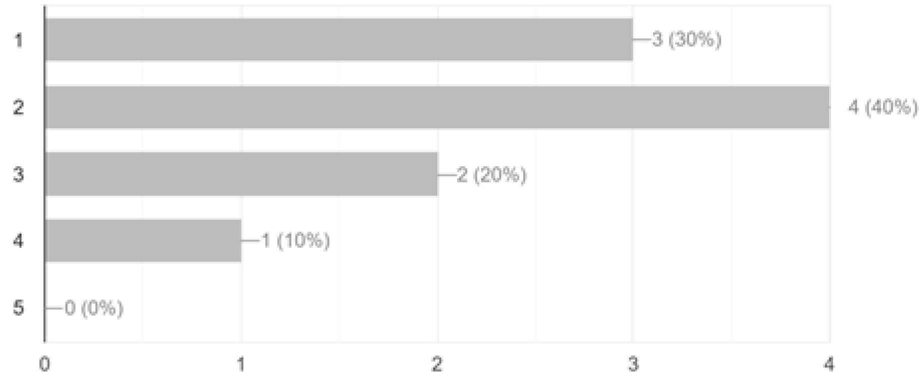
4 = Good level of establishment/equipment/preparedness

5 = High level of establishment/equipment/preparedness

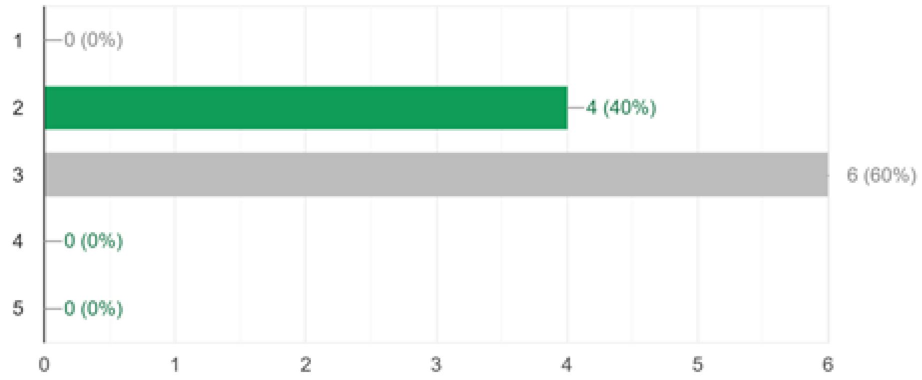
1. At what level is the office for disaster risk management located?



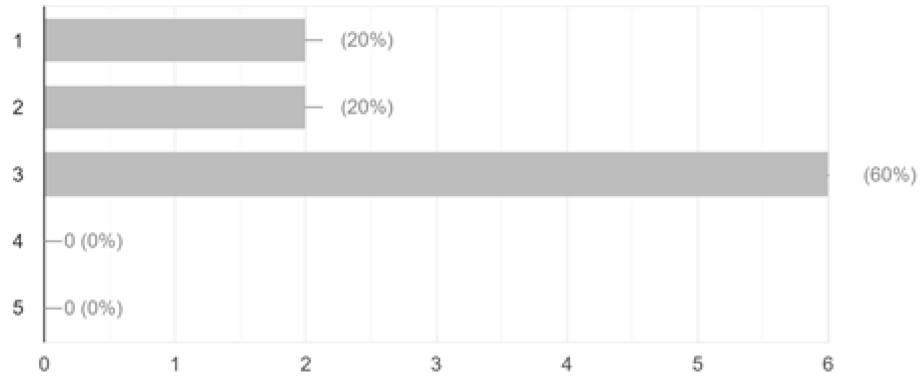
2. At what level is the Office for Environment, Sustainability, and Climate Change located?



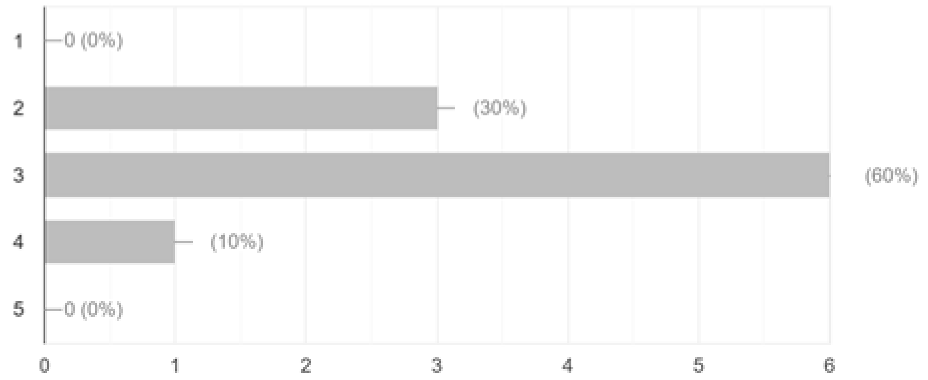
3. Are the responsibilities clearly specified at the city level?



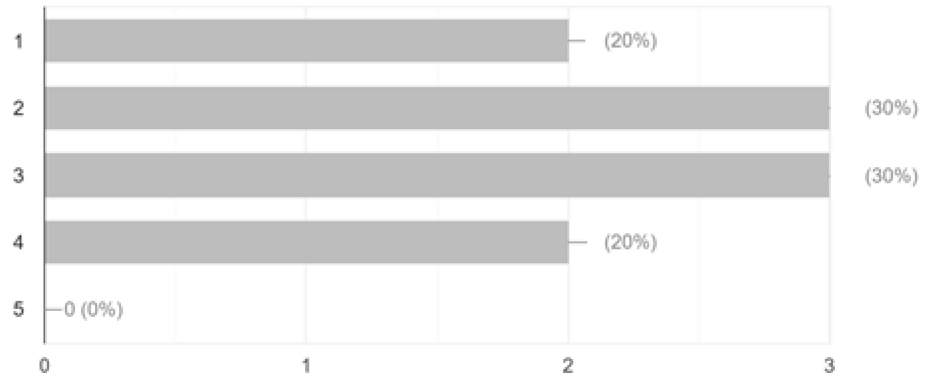
4. Has the responsibility for managing the consequences of climate change been established?



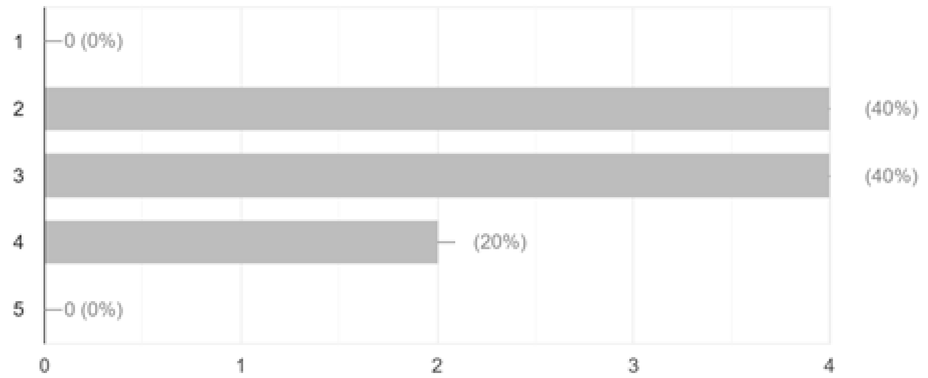
5. To what extent has the responsibility for managing disaster risks been established?



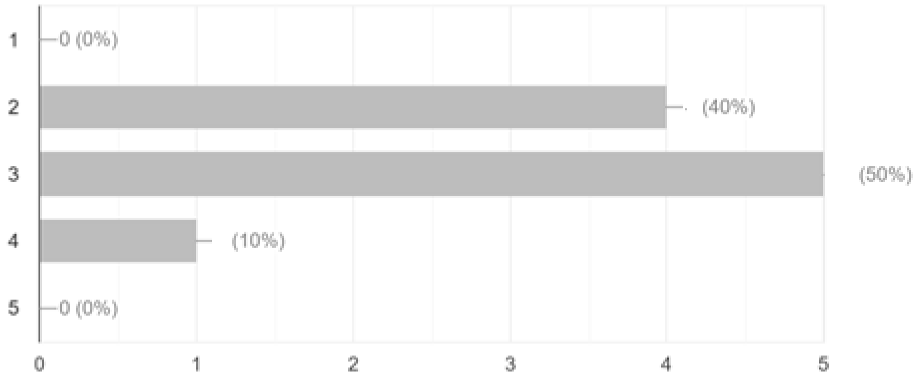
6. Is there a city disaster response plan, and what is its capacity and effectiveness?



7. How is the system for disaster response structured in terms of comprehensiveness and available equipment?



8. What is the level of update of the disaster response system at the city level?



ANNEX B - Local participative event "Local Methodological Workshop - Urban Heat Islands"

Date: 18.09.2024

Place: City of Zenica

1. Brief description of the workshop activities and outcomes

   Zenica's local workshop, which took place in hotel Zenica on September 18, 2024, focused on assessing the effects of urban heat islands in Zenica. At the beginning of the workshop BE READY's video was displayed and a brief presentation on Be Ready project was presented. Barbara Mušič from the Urban Planning Institute of Slovenia has presented the urban heat risk and vulnerability assessment methodology to local stakeholders. The city also presented its ongoing and planned projects to reduce these impacts through green and blue infrastructure. At the workshop, Amra Mehmedić and Haris Alić detailed the pressing issue of urban heat islands (UHIs) affecting the city, providing a comprehensive look at current conditions and discussing future initiatives aimed at mitigation. They presented projects focusing on green and blue infrastructure, such as planting more vegetation and creating reflective surfaces, to combat rising urban temperatures. The goal of these efforts is to enhance Zenica's climate resilience by reducing heat concentrations and promoting sustainable urban development, ultimately fostering a healthier urban environment.

This session allowed stakeholders to explore collaborative solutions and share expertise, creating a foundation for informed, effective responses to UHIs in Zenica.

The workshop concluded with the signing of a coalition pact by 14 participants, marking a commitment to collaborate on urban heat island mitigation strategies in Zenica. Additionally, all participants completed evaluation forms.

2. Recommendations for UHI vulnerability and risk assessment

- Monitor temperatures in pilot location using temperature sensors and satellite imagery, and all other forms of monitoring.
- Gather data on land use, vegetation cover, surface materials, and building density.
- Engage urban planners, environmental agencies, and community representatives to review data and develop mitigation strategies collaboratively.
- Apply geospatial models to map heat distribution and predict UHI patterns specific to the pilot location.
- Analyse demographic and economic data alongside temperature data to prioritize areas with vulnerable populations.

- Evaluate and map areas needing more vegetation or reflective surfaces to reduce heat buildup.
- Create a continuous monitoring system and gather regular feedback to adjust and improve UHI mitigation efforts.
-

3. Target group attendees

Target group		Number
Local authority		8
Regional authority		-
National authority		-
Interest groups and NGOs		5
Business support organizations		2
Cross-border legal body		1
General public		5
Higher education and research organization		2
Gender	Men	14
	Women	9
	Other	-

4. Workshop evaluation results

The workshop aimed to assess and address the effects of urban heat islands (UHIs) in the city. With a focus on collaboration and practical solutions, it gathered 14 stakeholders who represented various local sectors.

Participants found the workshop engaging and insightful. The methods and tools for assessing UHI effects, presented by Barbara Mušič from the Urban Planning Institute of Slovenia, were particularly well-received. Stakeholders appreciated the chance to gain new knowledge on urban climate challenges and mitigation tools. Participants recognized the potential of green spaces, vegetation, and reflective surfaces in reducing urban temperatures. The detailed presentation of Zenica's planned projects to integrate these solutions was met with positive feedback, with stakeholders noting that they felt empowered to support these initiatives within their own organizations. The workshop successfully fostered collaboration among attendees, enabling them to exchange expertise and ideas.

The coalition pact signed by all participants (14) reflects a collective commitment to developing and implementing UHI mitigation strategies in Zenica.

5. Photos from the event


Be Ready
19 project partners
12 countries
12 pilots
30 months
2,4 million euro
1,9 million euro Interreg funds
HOTEL
Zenica