Interreg Danube Region

Co-funded by the European Union

Be Ready

Urban heat islands vulnerability and risk assessment

Chișinău, Republic of Moldova

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
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Place and date	Chișinău, 28.02.2025

The development of the Urban heat islands vulnerability and risk assessment was supported by the *UrBan hEat islands REsilience, prepAreDness and mitigation strategy (BeReady),* an Interreg Danube Region Programme project co-funded by the European Union.

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List of Abbreviations

UHI	Urban Heat Island
ASP	Associated Strategic Partner
MS	Meteorological Station
BCR	Building Coverage Ratio
FAR	Floor Area Ratio
NBS	National Bureau of Statistics
ILO	International Labour Organization
lei	Moldova's national currency
DGAMS	General Directorate of Medical and Social Assistance
GHG	Greenhouse Gas
UNFCCC	The United Nations Framework Convention on Climate Change
CCA	Climate Change Adaptation
GD	Government Decision
NARD	National Agency for Research and Development
SNASC 2020	Moldova's Climate Change Adaptation Strategy until 2020
LPAs	Local Public Authorities
GDP	Gross Domestic Product

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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).

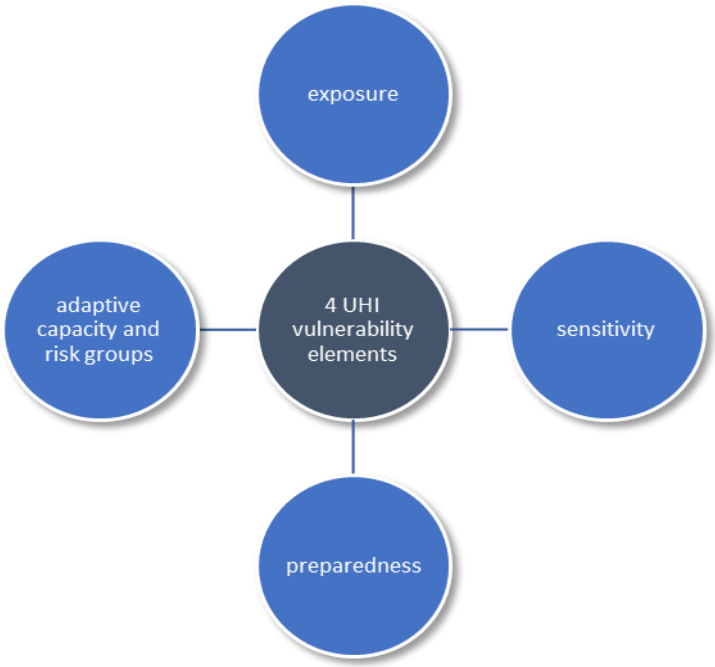


Figure 1: 4 UHI vulnerability elements

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: Chișinău

Municipality of Chișinău

Central Region

Republic of Moldova

Statistical data

Surface Area of the municipality - 571.64 km2

Area of the City - 120 km2

Population of the city (on January 1st, 2023) - 672 967

Density - 5,576 inhabitants/km²

GDP per capita - 6,319 €

Minimum Wage in 2024 - 258.3 €/month, equivalent to 3,100 €/year

ABOUT THE CITY

Chișinău Municipality is an administrative-territorial unit of the Republic of Moldova, a city with a special status of a municipality.

Chișinău Municipality is the capital and largest city of the Republic of Moldova. It is the administrative, socio-political, economic, scientific and cultural centre of the country. The first mention of Chișinău dates back to 1436. The city status was obtained in 1818, and the status of a municipality Chișinău - in 1995.

Chișinău Municipality is a higher-level administrative-territorial unit, along with districts. A municipality is an urban-type settlement that plays a special role in the economic, socio-cultural, scientific, political and administrative life of the country and has important industrial and commercial structures, educational, health and cultural institutions.

Chișinău is located in the central region of Moldova at an altitude of 85 m above sea level, in the East European Plain. The city is located on seven hills and is crossed by the Bîc River, a right tributary of the Dniester River. The part of Chișinău on the right bank of the Bîc River occupies terraces above the floodplain.

The town is located on the edge of the south-eastern slope of the Central Plateau of Moldova, in the forest-steppe zone. The predominant soil is black soil (cernoziom), ideal for agricultural development. Among minerals, limestone is widespread, rich in well-preserved fossils.

In Chișinău there is the Ghidighici reservoir, the largest, and 23 other lakes.

Figure 2: Location of Chișinău on the map of Moldova

Source: https://commons.wikimedia.org/wiki/File:Chișinău_in_Moldova_%28city_%2B_district_hatched%29.svg

2. Methodology of the assessment

SUMMARY OF THE PROCESS

In the framework of the analysis of the Urban Heat Island phenomenon in Chișinău, the assessment process was initiated with the aim of understanding the impact of urbanization on local temperatures and proposing effective solutions.

The process began with the development of a preparatory plan, which included defining the objectives of the assessment and establishing success criteria. An essential aspect was the identification of key stakeholders, such as local authorities, central authorities, environmental organizations and the community, to ensure a collaborative approach.

Stakeholders were involved in the process in several stages. In the first stage, initial consultations were held to understand their perspectives and needs. This was followed by a series of workshops. The involvement through organized events was crucial to ensure that the assessment reflected the realities and concerns of the community.

A detailed calendar was developed to organize the assessment activities, including consultations, workshops and feedback meetings. Each activity was planned with the aim of ensuring relevant stakeholder participation, thus facilitating effective collaboration.

Five events/activities were organized in the assessment process, including two consultation workshops, one feedback session, two assessment meetings and a focus group discussion. Each of these activities had a specific purpose, contributing to the progress of the assessment process.

In conclusion, this assessment process was essential to understand and address the effects of UHI in Chișinău, actively involving stakeholders and ensuring a collaborative approach that reflects the needs and concerns of the community.

PREPARATORY PHASE

In the preliminary stage, a comprehensive assessment of all accessible information sources was conducted, alongside the identification of local stakeholders and their contributions. Gaps in data were recognized, and strategies for gathering the required information through various methods were established.

EVENTS/ ACTIVITIES

Several events/activities were organized to aid the assessment:

- A local planning workshop aimed to gather preliminary input and information from a diverse group of stakeholders, including local authorities, environmental organizations, community representatives, and urban planners. This collaborative setting was essential for understanding

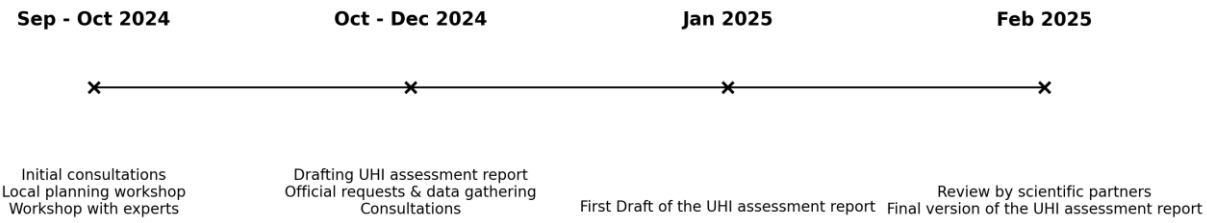
the unique challenges and opportunities related to urbanization and its impact on local temperatures.

- A specialized workshop was convened, bringing together experts and professionals from various fields to share their knowledge, insights, and best practices, thereby enriching the assessment process with their expertise on urban heat management and climate adaptation strategies.

- The feedback session event was held online and was designed to present preliminary findings and gather valuable input from the scientific partner. This session aimed to ensure that the assessment remained aligned with available data and community needs and perspectives.

- Two assessment meetings and a focus group discussion were conducted to facilitate in-depth discussions among stakeholders, focusing on data analysis, potential interventions, and collaborative strategies to effectively address the Urban Heat Island phenomenon in Chișinău.

TIMELINE OF THE PROCESS



3. Urban climate

GENERAL INFORMATION

Chișinău is located in a temperate continental climate zone. Winter is mild and short; summer is warm and long. Meteorological observations are made regularly (every 3 hours) at the Chișinău Hydrometeorological Centre.

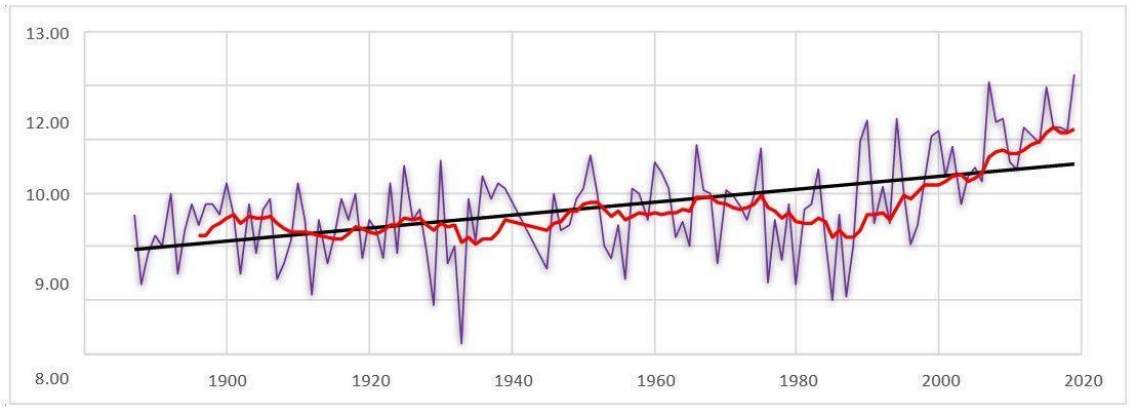
The first meteorological observations were made in 1844, and systematic observations were made only in 1886–1940 at the Real High School and in 1885–1923 at the Winemaking School. Intensive research in the field of climate began in the post-war years at the weather stations in Rîșcani (1944–1959) and Revaca (from 1959), as well as at the Chișinău Hydrometeorological Centre.

The annual sunlight is 2215 hours, the strongest and longest being recorded in July (329 hours), and the shortest – in December (54 hours). There are 71 days without sun (with 100% cloud cover) per year, most of which occur in winter (40 days). In June and September, one day without sun is recorded, while in July–August such days are almost completely absent. Winds from the north and northeast directions predominate, in winter they can also blow from the southeast. The average annual wind speed ranges between 2.5 and 4.5 m/s, the strongest being recorded in February–March, and the weakest in September–October.

CLIMATE TRENDS

Regarding historical climate change trends, over the past 133 years, Moldova has experienced changes in average temperature and precipitation. The climate in the country has become warmer, with an average temperature increase of 1.2°C, while the increase in average precipitation volumes has been only about 51.3 mm.

Figure 3: Trends in change in average annual air temperature (°C) for the years 1887-2019: purple line (current trend), solid black line (linear trend over a century) and red line (10-year moving average trend) at the oldest meteorological station in the Republic of Moldova located in Chișinău, in the central part of the country.



Source: https://www.meteo.md/images/uploads/gis/meteo/Tendinta%20schimb_temp.pdf

Thus, the changes observed in the climate of the Republic of Moldova over the past century are in line with global and regional trends associated with climate change caused by human activities. In the coming centuries, an upward trend in these changes is forecast.

In the urban environment, climate change is having negative effects on human health and infrastructure. High temperatures, including heat waves, have intensified in cities, generating cases of air pollution and limited functioning of key infrastructure. Urban infrastructure, including transport, water supply, sanitation and energy systems, are affected by extreme events, causing economic losses, disruptions in service provision and impacts on the well-being of the population.

Air Temperature

The average temperature is 20.5 °C, and the absolute maximum is 43 °C, in July and August. The end of autumn is determined by the temperature dropping below 0 °C, which lasts approx. 2 months, and long-term atmospheric precipitation. The average temperature in autumn is almost 10 °C (9.9(6)°C).

Winter lasts about 78 days, with unstable temperatures: on average, -2.3 °C. The minimum temperature, -31.5 °C, was recorded in 1937. Spring lasts about 70 days, during which the average temperature is 9.3 °C. Summer begins in mid-May and ends around September 20.

Higher air temperature in certain regions of the municipality is caused by the activity of industrial enterprises, transport, heating of asphalt caused by solar radiation, etc.

On average, the temperature inside the city of Chișinău is 0.7 °C higher than outside it.

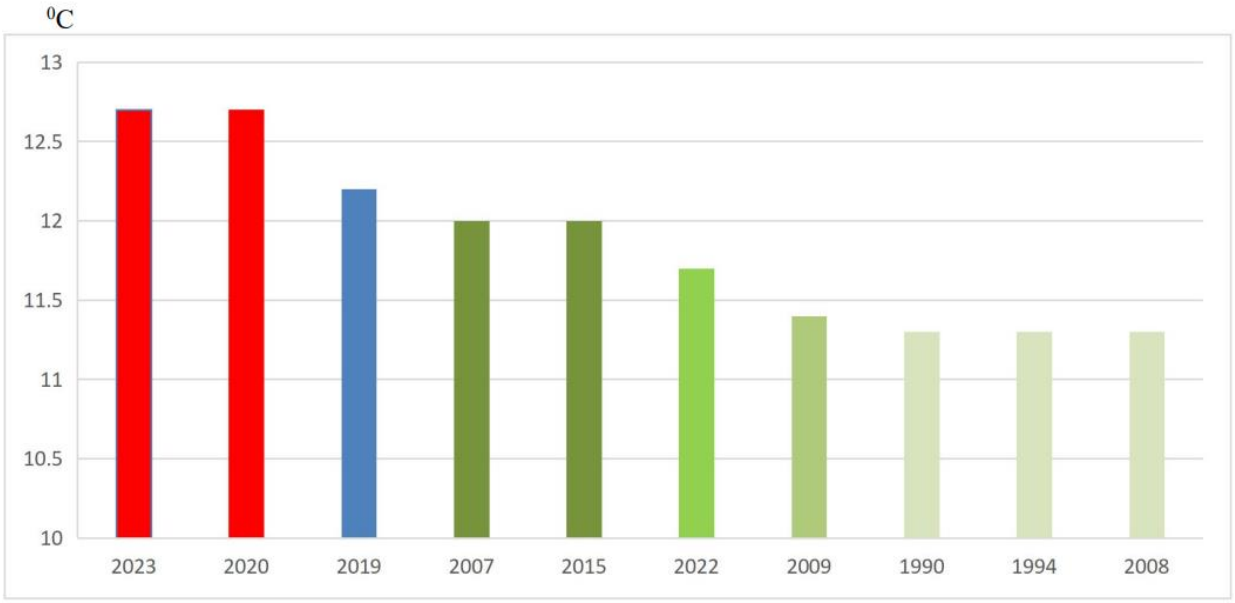
Table 1: Annual and extreme air temperature

Weather indicators	Months of the year												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Average temperature, °C	–3,5	–2,5	2,6	9,5	15,8	19,3	21,5	20,7	15,9	10,1	3,9	–0,9	9,4
Absolute maximum temperature, °C	15	16	25	32	36	37	39	39	37	33	28	16	39
Absolute minimum temperature, °C	–30	–32	–23	–9	–2	4	8	7	–1	–16	–22	–22	–32

Source: https://www.meteo.md/images/uploads/clima/anul_2023.pdf

According to data from the Chișinău meteorological station (observation period 129 years), the average annual air temperature was +12.7ºC (2.9°C higher than the norm) and ranked 1st in the series of years with high average annual temperatures, as well as 2020 (Fig. 4).

Figure 4: Series of years with high average annual temperatures, MS Chișinău



Source: https://www.meteo.md/images/uploads/clima/anul_2023.pdf

Surface Temperature

The soil surface temperature in Chișinău municipality has varied significantly over the past 10 years, influenced by weather conditions and climate change. Usually, soil temperature is monitored at a depth of 5 cm or 10 cm, and these data are essential for climate, agricultural and ecological research, as they influence plant germination processes, water evaporation and soil dynamics.

In Chișinău municipality, soil temperature shows a high seasonal and annual variability. It can reach maximum values during summer and minimum values during winter. For a detailed description, it should be noted that accurate soil temperature data are not always easily accessible to the general public, but certain international climate sources and platforms can provide relevant estimates based on satellite data and weather stations.

Factors that influence soil surface temperature:

Seasonality: Soil temperatures are highest in the summer months (June – August), when the sun heats the soil intensely. Conversely, soil temperatures are lowest in the winter months (December – February), when frost can affect the top layer of soil.

Precipitation: Precipitation influences soil temperature through evaporation and soil cooling. During periods of heavy rain, the soil can remain cooler, and during dry periods, the temperature can increase significantly.

Humidity and wind: Higher humidity can contribute to soil cooling, and wind can accelerate the cooling process, especially at night.

Albedo and soil type: The type of soil and its color (albedo) influence how much heat is absorbed by the soil. For example, sandy soils absorb more heat than clay soils.

Soil surface temperature in Chișinău: long-term trends (last 10 years)

Although exact data is not always readily available, a general description of soil temperatures in Chișinău over the last 10 years can be summarized based on some general climate trends:

Increasing average temperatures: Over the last decade, Chișinău has experienced a trend of increasing average temperatures, a phenomenon associated with global climate change. This is manifested by warmer summers and milder winters, with a higher number of days with high soil temperatures during the summer.

For example, in 2014 and 2015, the annual average soil temperatures at a depth of 5 cm were around 10-11°C, while in 2018 and 2019, these values increased to 12-13°C. This suggests a gradual increase in temperature, consistent with the general climate change trends observed in Eastern Europe.

Annual variability: Soil temperatures can vary significantly from year to year, depending on the meteorological factors specific to each year. For example, years with prolonged droughts, such as 2015 and 2017, recorded higher soil temperature values due to the lack of precipitation and long-term high temperatures.

In contrast, years with more abundant precipitation, such as 2016 and 2019, had lower soil temperatures, especially in the spring and summer months.

Seasonality: Summer (June – August) is the period when soil temperatures reach maximum values, often exceeding 30°C on some days. During this period, the soil can accumulate heat during the day, and temperatures can even reach 40°C in conditions of intense sunlight.

Winters (December–February), on the other hand, are characterized by very low soil temperatures, often below 0°C. During periods of frost, the soil can freeze, especially in January, when average air temperatures frequently drop below -5°C.

Recent trends and climate change: Long-term climate data suggest a warming climate in Chișinău, with a trend of increasing maximum soil temperatures and a prolongation of periods of extreme heat. For example, in years with heat waves (such as 2018), soil surface temperatures reached values above 40°C on certain days, which affects agriculture and the environment.

Additional observations: Changes in precipitation regime: In recent decades, Chișinău has experienced a decrease in precipitation in the warm season, and this has contributed to an increase in soil temperature, especially during summer. More frequent droughts can cause the soil to become drier and absorb more heat, contributing to higher surface temperatures.

Therefore, over the past 10 years, the surface temperature of the soil in Chișinău has registered a general upward trend, associated with global climate change and changes in the precipitation regime. Maximum soil temperatures have reached high values during the summer, and winters have become milder. These changes have a significant impact on the environment, agriculture and ecosystems in the region.

Solar Radiation

Solar radiation is one of the main sources of renewable energy, the use of which is not associated with negative impact on the environment. For these reasons, solar energy fully satisfies the sustainable development of society by ensuring a rational use of natural resources and the

development of energy-efficient technologies in the conditions of climate change, and the assessment of the climate resources of solar radiation has not only a fundamental but also an applied character.

Observations on solar radiation are carried out only at the Chișinău meteorological station, the data of which are representative for the entire country. Global solar radiation, measured at the Chișinău meteorological station, in the intervals 1961-2020, was evaluated as presented:

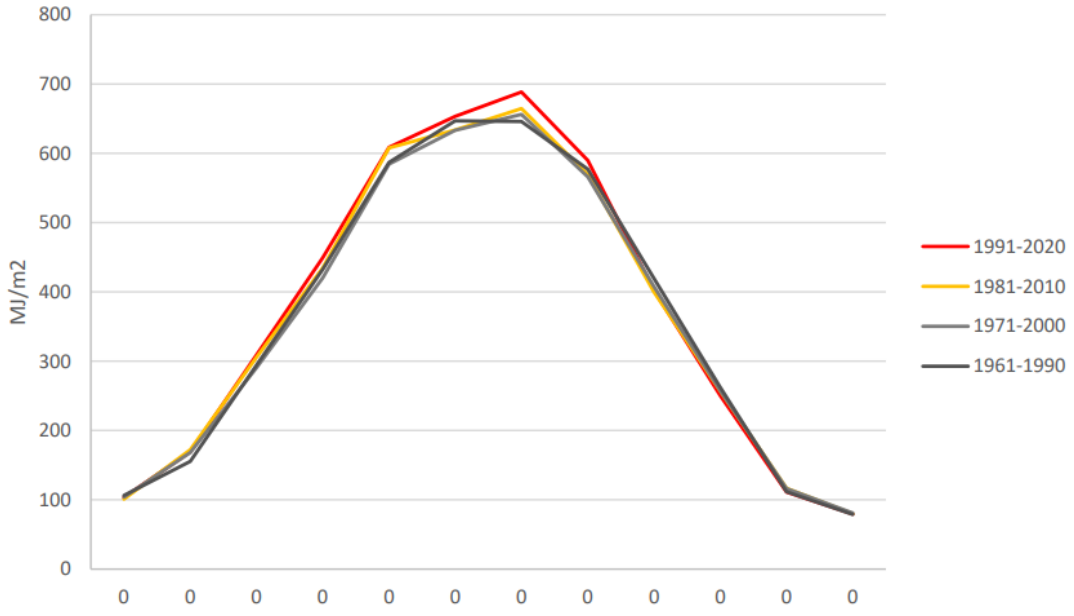
Table 2: Global solar radiation recorded at the Chișinău meteorological station, MJ/m²

Observation period	Multi-year average	Average during the warm period of the year (May-September)	Average during the cold period of the year (October-April)
1961 - 1990	4318	2877	1441
1971 -2000	4285	2848	1437
1981 - 2010	4342	2776	166
1991 - 2020	4416	2943	1473

Source: https://www.meteo.md/images/uploads/clima/researches/Evaluarea_resurselor_solare.pdf

To be noted that from the 1980s to the present day, the multiannual average values of global solar radiation have been increasing, the difference between the average values of the period 1991-2020 and those of 1971-2000 increased by 131 MJ/m² (3.1%), and for the warm and cold periods of the year – by 95 (3.3%) and 36 (2.5%) MJ/m², respectively.

Figure 5: Monthly average variation of global solar radiation for different periods



Source: https://www.meteo.md/images/uploads/clima/researches/Evaluarea_resurselor_solare.pdf

The period 1961-1990 is described by a lower global radiation, but due to the lack of previous observation data, we cannot highlight any finite cycle, which is also confirmed by the general

graph of the evolution of the parameter over time for the entire period of available data 1954-2021.

Similar to global solar radiation, direct radiation has been increasing since the 1980s – the difference between the values of the period 1991-2020 compared to those of 1971-2000 is 333 (15.3%) MJ/m², and in the warm and cold periods, respectively, 249 (16.0%) and 84 (13.7%) MJ/m². In the case of direct solar radiation, the phase of increase in values starting from the 1990s of the 20th centuries is even better expressed, but due to the lack of observation data prior to the 1960s, we cannot highlight any finite cycle.

Both global radiation and direct radiation increased significantly during the warm period of the year. The maximum annual average value was recorded in 2007 – 4755 MJ/m² (7.1% above the average for the respective period and the severe drought in the summer of that year should be mentioned). The minimum multiannual average value of direct solar radiation was recorded in 1992 – 1862 MJ/m² (25.6% below the average for the respective period). The maximum multiannual average value was recorded in 2015 – 2937 MJ/m² (17.4% above the average for the respective period and the severe drought and heat wave in the summer of that year should be mentioned).

Therefore, the amplification of climate change since the 1980s is expressed by the increase in the amount of direct and global solar radiation, accompanied by an increase in the duration of sunshine, an increase in the duration of sunshine on a sunny day and a decrease in the number of days without sunshine.

Humidity

Relative air humidity varies little during the year but much in limited periods of time. The highest – 82-84 percent – is recorded in winter. In the warm period (April–September) the relative humidity is 61–66%. In summer the highest humidity – 64 percent – is recorded in June, when there is a lot of atmospheric precipitation. The minimum humidity, equal to 61 percent, is recorded in April–May and does not coincide with the maximum air temperature.

Table 3: Relative air humidity and average humidity

Weather indicators	Months of the year												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Relative air humidity (average % in 24h)	82	81	74	61	61	64	62	62	66	73	82	84	71
Average humidity (in %, at 13 h)	76	74	62	45	45	48	45	44	46	55	74	79	58

Source: Idem

Wind Speed and Direction

In Chișinău, winds from the north and northwest directions prevail; in winter, southeast winds are possible, resulting from the Siberian anticyclone. The average annual wind speed ranges from 2.5–4.5 m/s, the strongest (3.2 m/s) occurring in February, and the weakest (2.2 m/s) – in September–October.

Storms can occur in the warm period and are most often accompanied by torrential rains, often with hail. On the Beaufort scale, Chișinău winds vary from 0 to 8 degrees, very rarely exceeding.

Precipitation

In the Republic of Moldova, 2023 was characterized by a high thermal regime and a significant deficit of precipitation in the period August-October. The annual amount of precipitation in 2023 was 335-515 mm in the central part of the country, where the municipality of Chișinău is also located.

Atmospheric precipitation (deposition) is not constant throughout the year. Most of it (77%) falls in the warm period. In winter, precipitation falls both in the form of sleet and snow, less often in the form of rain. In January, snow accounts for 26 percent of total atmospheric precipitation, and in December – 51 percent. The first snow falls at the beginning of December, but it does not snow every day.

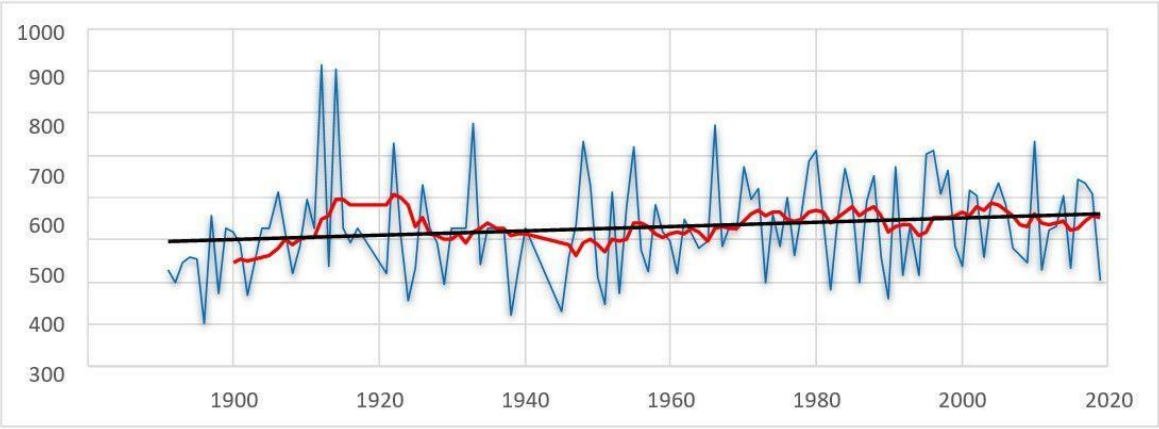
Table 4: Monthly and annual precipitation (mm) in 2023

Weather indicators	Months of the year												Annual
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Atmospheric precipitation, mm	25	17	27	133	13	20	61	2	15	10	94	15	432

Source: https://www.meteo.md/images/uploads/clima/anul_2023.pdf

The minimum amount of precipitation (22 mm) is recorded in August, and the maximum (133 mm) in April. Precipitation in the summer period is torrential. The annual amount of atmospheric precipitation in the city (480 mm) is 20–40 mm higher than in its surroundings.

Figure 6: Trends in the average annual precipitation (mm) for the years 1891-2019: blue line (current trend of the course), solid black line (linear trend over a century) and red line (moving average trend over 10 years) at the oldest meteorological station in the Republic of Moldova located in Chișinău, in the central part of the country.



Source: https://clima.gov.md/climate-next/page/schimbarea-climei-in-moldova

The last 30 years analysed (1991-2020) by the State Hydrometeorological Service are characterized by a general decrease in the average annual precipitation falling on the territory of the Republic of Moldova. On average, the amount of precipitation decreased by 14 mm or 2.52% compared to the years 1961-1990.

Urban Climate Overview of Chișinău

Chișinău, the capital of the Republic of Moldova, is situated in a temperate continental climate zone characterized by mild winters and warm, extended summers. Meteorological observations have been conducted since 1844, with systematic data collection beginning in the late 19th century. The city experiences an average annual temperature of 20.5°C, with extremes reaching up to 43°C during the summer months. Notably, the average temperature within the urban area is approximately 0.7°C higher than in surrounding rural regions, primarily due to urbanization effects such as industrial activities and increased impervious surfaces.

Over the past century, Chișinău has witnessed a significant rise in average temperatures, with a recorded increase of 1.2°C, while precipitation levels have shown only a modest rise of about 51.3 mm. The annual sunlight exposure averages 2215 hours, with the highest levels occurring in July. However, the city also faces challenges such as high humidity levels, particularly in winter, and a notable decrease in annual precipitation over the last three decades.

The urban environment is further impacted by the Urban Heat Island (UHI) effect, where densely built areas with limited vegetation experience higher temperatures. This phenomenon is exacerbated by the predominance of heat-retaining materials like concrete and asphalt, which contribute to elevated surface temperatures, particularly in central and industrial zones.

The findings underscore the urgent need for sustainable urban planning and green infrastructure initiatives to mitigate the adverse effects of climate change and enhance the resilience of Chișinău's urban climate.

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

EXPOSURE OF BUILDINGS AND SURROUNDINGS

Urban morphology/urban form

Chișinău Municipality is a second-level administrative-territorial unit of the Republic of Moldova. It includes the capital of the country, the city of Chișinău itself, and 34 settlements, including 6 cities and 28 villages in the immediate vicinity (suburbs) of the city.

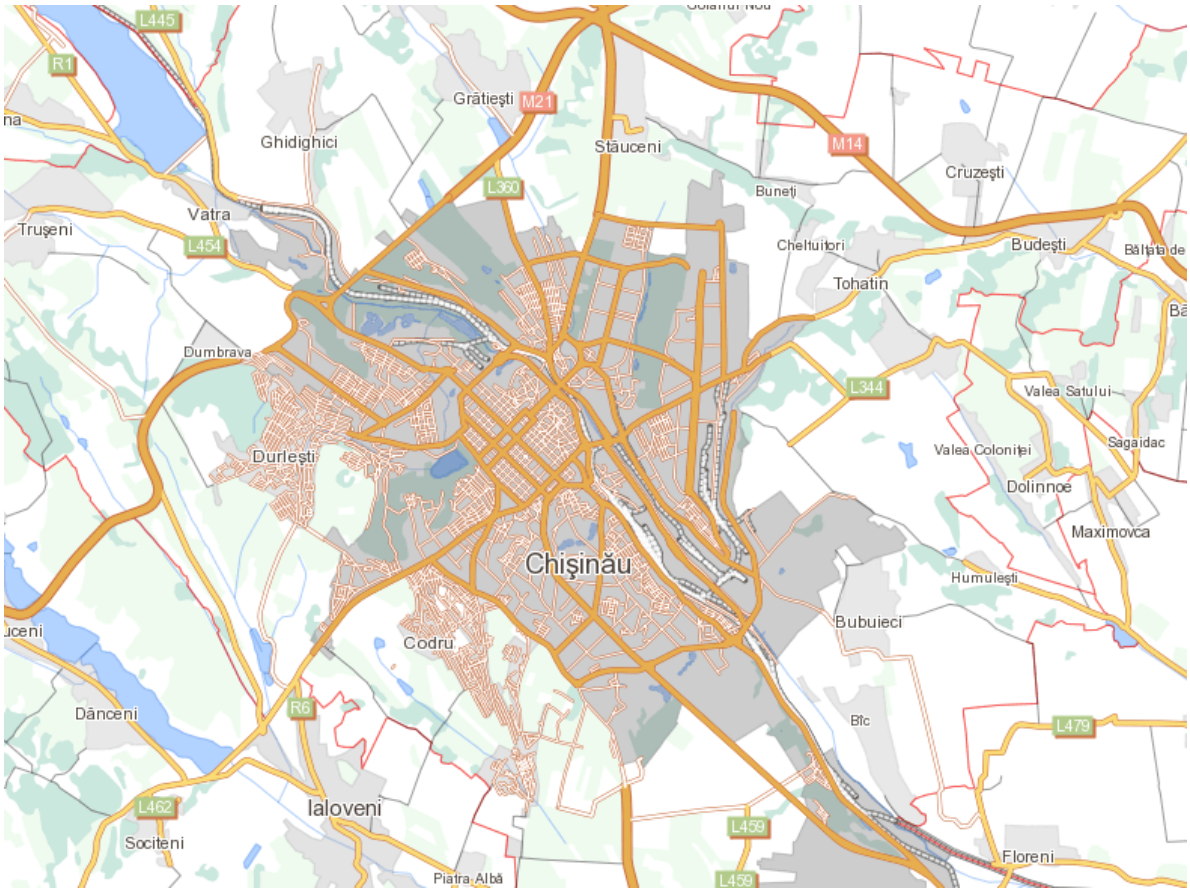
The urban planning form of Chișinău can be viewed as an agglomeration. An agglomeration is a compact territorial distribution of urban settlements, with intensive economic, labour, cultural and economic ties.

The agglomeration of Chișinău is the most active in the Republic of Moldova, due to its administrative resources, population size, concentration of financial and investment capital, maximum volumes of housing, industrial, socio-cultural and commercial constructions.

Chișinău is a growth pole for the economic and social development of localities in its area of influence. From the point of view of urban planning, special attention is paid to the interaction of the Chișinău agglomeration with the neighbouring districts: Ialoveni, Strașeni, Anenii Noi, located 10-20 km away. At the current stage, Chișinău follows a mixed urban system, in which territories

within the city are actively exploited, but the process of developing suburban areas takes place more passively.

Figure 7: Map of Chișinău Municipality



Source: https://www.Chișinău.md/ro/harta-orasului-Chișinău-pe-pagina-oficiala-a-primariei-20292_238522.html

The planning structure of Chișinău is polycentric, where, along with the main core, there are several local subcentres of urban significance. The city's territory is characterized by an indistinct division into residential, industrial and natural areas. The presence of natural and artificial separators forms the planning framework and affects the nature of the territories, the possibilities of development, transformation.

The natural separators of the territory are the Bîc River and the Dniester River. Natural objects such as the water reservoir - Lake Ghidighici and the Codrilor forests, which serve as important constraints for the development of urban areas, have a significant impact on the planning framework.

Industrial zones formed along the railway and a developed linear transport network serve as technogenic separators and create impediments to the development of the city.

The relative lack of suitable land for construction and the difficulty of developing new territories due to natural factors influenced the compactness of the city's planning structure.

Residential areas are characterized by three types of development: dense development of micro zones in the central part, super-dense development of new micro zones, as well as individual residential blocks in the suburbs.

The city develops along the main planning axis - the Bîc River in the direction from north to south. All streets in the latitudinal direction obey the bend of the river.

In the meridional direction, the main planning axis is Ismail Street, which stretches across the entire territory of the municipality. Conventionally, the city can be represented in the form of 4 planning matrices - east, west, north and central.

Figure 8: Administrative-territorial organization of Chișinău Municipality

Source: https://www.Chișinău.md/en/development-of-the-Chișinău-investment-map-20292_245517.html

Administratively, Chișinău Municipality is divided into 5 sectors, with the following suburbs:

1. Botanica Sector – southern part; includes the city of Sîngera and the commune of Băcioi;

2. Buiucani Sector – central and north western part; includes the cities of Durlești and Vatra, as well as the villages/communes of Condrița, Ghidighici and Trușeni;

3. Centru Sector – central and western part; includes the city of Codru;

4. Ciocana Sector – eastern part; includes the city of Vadul lui Vodă, as well as the villages/communes of Bubuieci, Budești, Colonița, Cruzești and Tohatin;

5. Rîșcani Sector – central and northern part; includes the city of Cricova and the communes of Ciorescu, Grătiesti and Stăuceni.

Chișinău, as the capital and largest city of the Republic of Moldova, spans a significant area and encompasses a diverse range of urban environments. Given its extensive size and the complexity of its urban fabric, obtaining comprehensive data to accurately calculate the Building Coverage Ratio (BCR) and Floor Area Ratio (FAR) indicators at the city-wide level presents considerable challenges. The variability in land use, building density, and urban morphology across different districts complicates the collection and analysis of relevant data.

To address these limitations and ensure a more focused and manageable assessment, it was decided to narrow the study area to a specific district within Chișinău. This targeted approach allows for a more detailed examination of urban metrics, facilitating precise calculations of BCR and FAR indicators. By concentrating on a defined sector, the study can yield more reliable insights into the urban heat island (UHI) effects and inform effective mitigation strategies tailored to the unique characteristics of that area. This decision underscores the importance of localized studies in understanding and addressing the complexities of urban climate challenges in a large city like Chișinău.

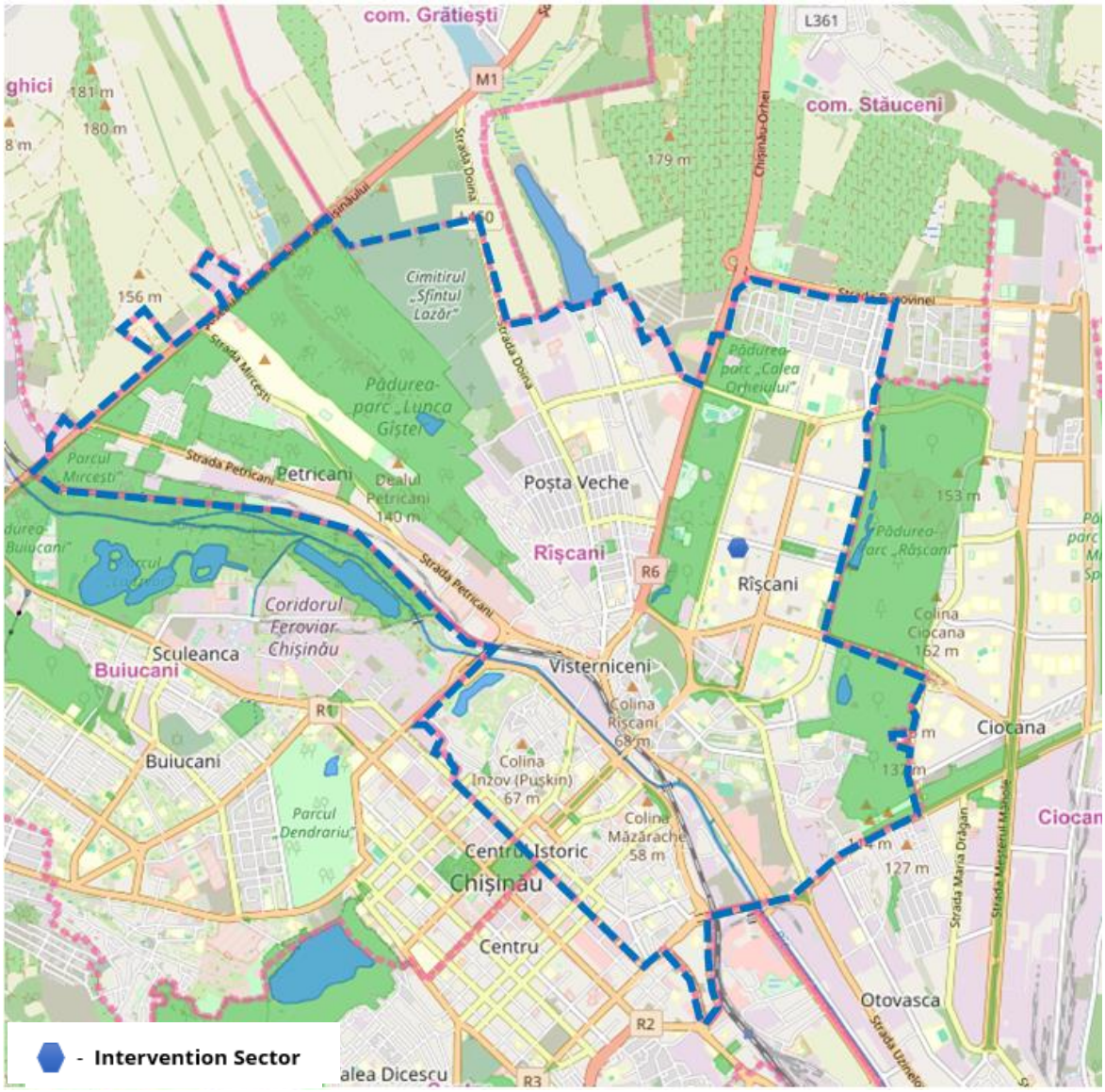
City Sector for UHI Intervention

Rîșcani was selected as the sector for the more detailed study. Rîșcani is one of the 5 sectors within Chișinău, characterized by a mix of residential areas, green spaces, and urban infrastructure. Its selection for a detailed study on Urban Heat Islands highlights the importance of understanding how urbanization impacts local climate and the potential for implementing effective cooling strategies.

Rîșcani is known for its diverse neighborhoods, which include both older, established residential blocks and newer developments. The sector features a variety of amenities, such as parks, schools, and commercial areas, contributing to the overall quality of life for its residents.

However, like many urban areas, Rîșcani faces challenges related to heat retention due to increased impervious surfaces, reduced vegetation, and urban sprawl. The study of Urban Heat Islands in this sector aims to identify specific heat patterns, assess the impact on public health and energy consumption, and explore potential interventions to mitigate these effects, ultimately fostering a more sustainable urban environment.

Figure 9: Delimited map of the Rîșcani Sector

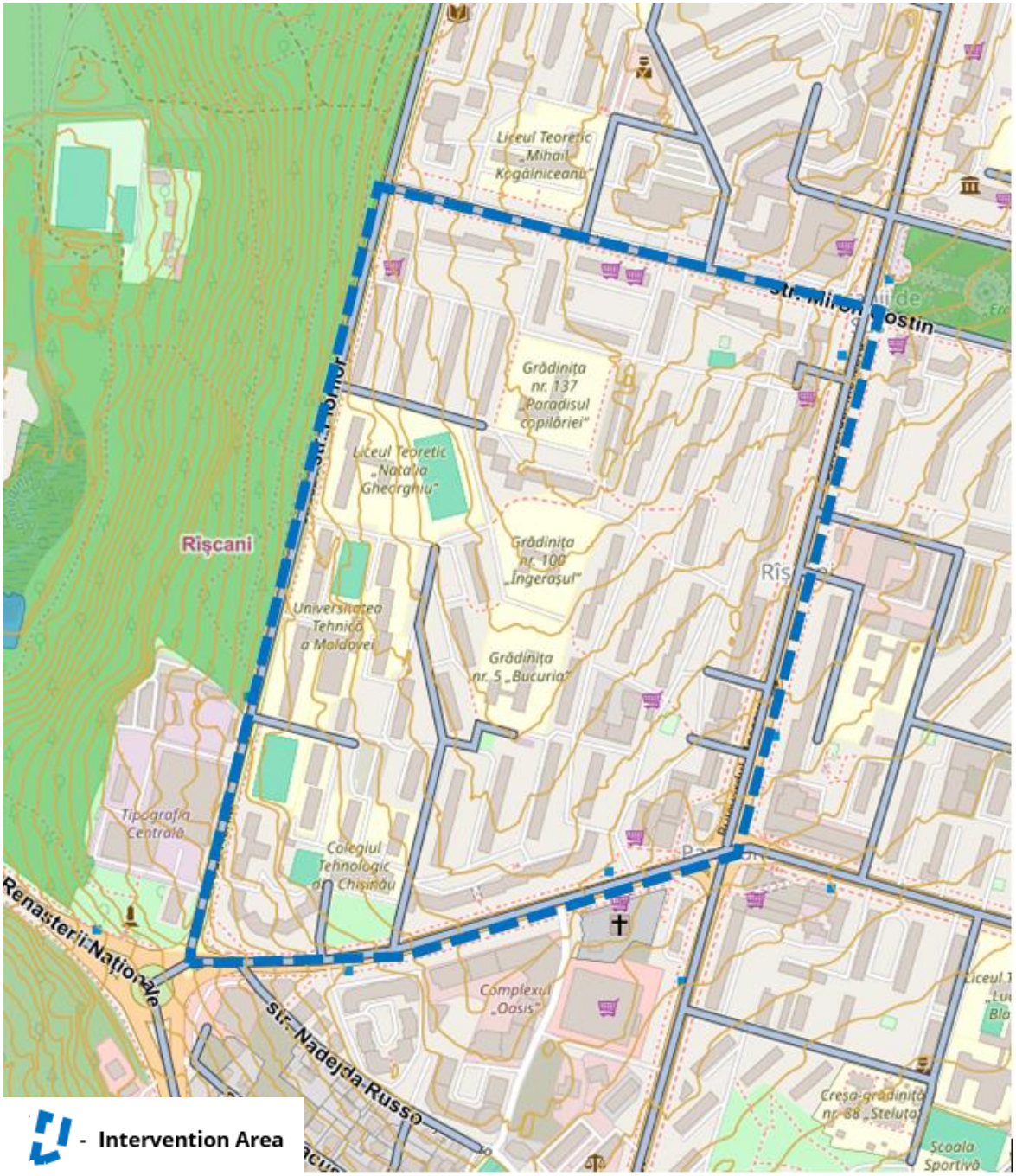


Source: www.gislocal.md

Area for UHI Intervention

Within Rîșcani Sector, a more narrowly defined area has been selected for the study to facilitate precise calculations of key urban metrics such as the Building Coverage Ratio (BCR) and Floor Area Ratio (FAR). By focusing on this specific zone, we can obtain detailed data on the extent of built-up areas relative to the total land area, as well as the density of construction in relation to the available space. These metrics are crucial for understanding how urban design influences heat retention and distribution within the sector.

Figure 10: Delimited map of the Area within Rîșcani Sector



Source: www.gislocal.md

Building coverage ratio (BCR)

Building Coverage Ratio (BCR)= building area (B) / area of the plot (P) :

BCR= 71 613 m2 / 373 625 m2= 0,192

In the selected area of Rîșcani, the analysis of urban metrics reveals significant insights into the built environment's characteristics. The Building Coverage Ratio (BCR) is calculated at 0.192, indicating that approximately 19.2% of the total plot area is occupied by buildings. This relatively low BCR suggests that there is a considerable amount of open space available, which can play a crucial role in mitigating the Urban Heat Island effect by allowing for vegetation and green areas that help cool the environment.

Floor area ratio (FAR)

Floor Area Ratio (FAR)= gross floor area (sum of all F) / area of the plot (P) :

FAR= 383 881 m2 / 373 625 m2= 1,027

Analysing BCR and FAR will provide valuable insights into the relationship between urban form and the Urban Heat Island effect, enabling the development of targeted strategies to enhance urban resilience and improve thermal comfort for residents.

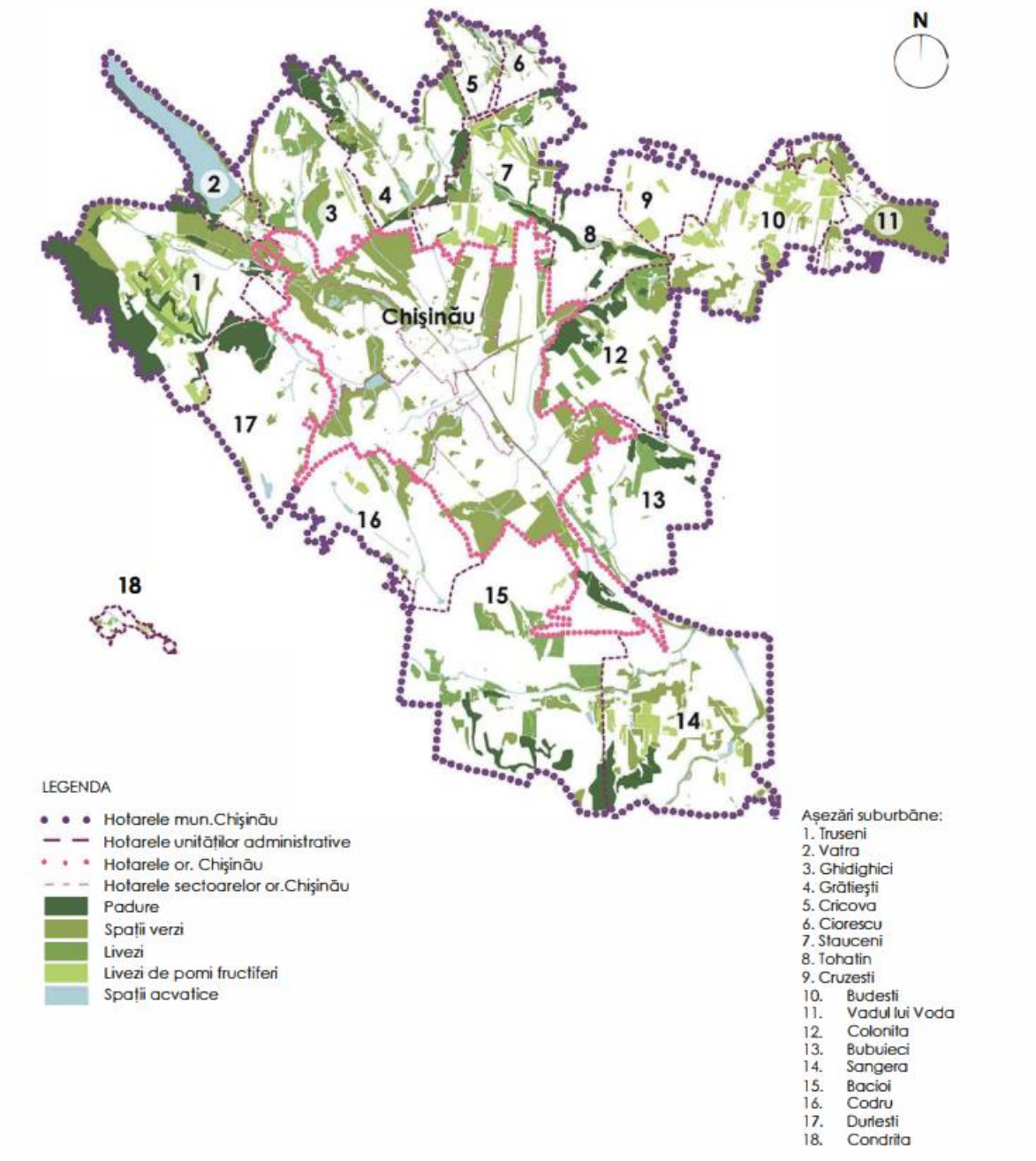
The combination of these metrics provides a comprehensive understanding of the spatial dynamics within Rîșcani, highlighting the balance between built structures and open spaces, which is essential for effective urban planning and climate resilience strategies.

The Floor Area Ratio (FAR) is determined to be 1.027, meaning that the total gross floor area of all buildings is slightly more than the area of the plot itself. This FAR value indicates a moderate level of density, suggesting that while the buildings occupy a smaller footprint, they extend vertically, contributing to the overall urban fabric of the sector.

Green urban spaces and vegetation

Urban green spaces in Chișinău are represented by 4 public gardens, 7 parks, 11 forest parks (forest parks) and 52 squares. The total area of green areas, according to the cadastre of public spaces, is 1971.52 ha. The largest share is held by forest parks in Chișinău, with an area of 1175.57 ha.

Figure 11: Scheme of green spaces in Chișinău Municipality



Source: Sustainable Socio-Economic and Spatial Development Strategy of Chișinău Municipality, page 398.

In the central area are located the Cathedral Park with an area of 9.3 ha, and the Public Garden of Stephen the Wise and the Saint, with an area of 7.4 ha. In these parks, the largest attractions of

the city are located - the Cathedral with the Bell Tower, the Triumphal Arch, the Monument to Stephen the Wise and the Saint.

The largest park in the city is the "Valea Morilor" Park, with a total area of 330 ha, on the territory of which is located the artificial lake "Valea Morilor", in the garden is arranged a staircase - the Staircase of the Falls. Around the lake there is a recreation area, a beach, there is also a small entertainment park. The forest area with pedestrian and cycling trails borders the green part of the park.

Another large park is "Valea Trandafirilor", which contains a cascade of lakes with a beach, equipped pedestrian areas, as well as a large number of commercial objects - banquet halls, restaurants, a hotel, a small entertainment park.

The Dendrarium Park, the Botanical Garden, the Zoo and the adjacent forest area can be referred to partially landscaped objects.

On the border between two sectors of Chișinău - Ciocana and Rîşcani, there is a park, founded in 1970, formed on the basis of a natural forest massif. The total area of the park is 32 hectares. The Park is divided into two parts by Alecu Russo Street, which intersects it. On both sides of the park there are lakes, which are inferior in size to the one at Valea Morilor.

The Park is located along Dimo Street in the Rîşcani sector and Sadoveanu Street in Ciocana. It is a favourite resting place for the residents of two sectors of Chișinău and one of the most visited parks of the capital. The Park is also interesting because in its upper part at Ciocana there are generally deciduous trees, while in its lower part, from Rîşcani, the pine forest, planted when the park was founded, predominates. The Park is very picturesque in any season of the year, especially in spring and late autumn. An excellent panorama of the city opens from the highest grounds.

A large wooded area in the western part of the city (250 ha) is located in the vicinity of industrial areas, which reduces the access of residents to the recreational area.

From the point of view of the legal framework in the field of green spaces, Law No. 591/1999 “on green spaces of urban and rural localities” regulates relations in the field of development and protection of green spaces of urban and rural localities in order to ensure the right of every person to a healthy and aesthetically pleasing environment.

According to the same law, green spaces, regardless of their affiliation and destination, serve to improve the quality of the environment, maintain the ecological balance and the local gene pool, enrich the assortment of ornamental plants, maintain and protect valuable natural objects and harmonize artificial landscapes with natural ones in order to achieve an environment favourable to the development of anthropogenic activities.

At the level of Chișinău Municipality, regulations in the field of urban green spaces are made through legislative acts adopted at the local level, by the General Mayor and the Chișinău Municipal Council. At the municipal level, the Chișinău Municipal Council adopted Decision 5/13 of 24.07.2018, in accordance with Law 591/1999 for the development, approval and maintenance of the cadastre of green spaces.

The management of green spaces in Chișinău is carried out by the Municipal Enterprise "Association for the Management of Green Spaces", founded on November 1, 1992 by the

Chișinău Municipal Council, which operates in the field of protection, maintenance and arrangement of green spaces located on the public domain within the urban area of Chișinău municipality.

According to the municipal authorities, in recent decades, the city of Chișinău has lost many hectares of green spaces through deforestation, chaotic construction in green areas, inadequate management with the lack of a strategic vision for expanding green spaces. In 1990, the area of green spaces within the built-up area of Chișinău municipality was 4,141.0 hectares, and in 2018 – already 3,656.9 hectares. Today, the exact boundaries of green spaces, the number, species and state of phytosanitary health of trees and shrubs in the city are unknown. Although in recent years a large part of valuable green spaces has been lost, few measures have been taken to preserve them. There is a need to rehabilitate green spaces and those open to the public in the city in order to establish playgrounds and green areas with abundant natural elements, for recreation and leisure purposes.

Green coverage ratio

Green cover in Chișinău refers to the areas covered with vegetation, including parks, gardens, public green spaces and urban vegetation. These areas play a key role in improving the quality of life of residents, contributing to reducing the UHI effects, improving air quality and managing stormwater.

Percentage of Green Cover

Estimates suggest that green cover in Chișinău ranges between 15% and 25% of the total area of the city, depending on the specific area. Central areas have lower green cover, while peripheral neighbourhoods benefit from more green spaces.

Types of Green Spaces:

- Public Parks: The largest and most accessible green areas, such as Valea Morilor Park and Dendrarium Park.
- Residential Gardens and Green Spaces: These include private gardens and green spaces between buildings.
- Urban Vegetation: Trees and shrubs planted on streets and in other public areas.

Figure 12: Map of green areas in the Chișinău City

Source: www.gislocal.md

Permeability of surfaces

Permeability of surfaces refers to their ability to allow water to pass through them, thus influencing stormwater management and contributing to flood prevention. In Chișinău, surface permeability varies significantly depending on the type of material used and land use.

Impervious Surfaces

Asphalt and Concrete: Most roads and sidewalks in Chișinău are covered with asphalt or concrete, which have very low permeability (approximately 0-5%). These surfaces contribute to water accumulation and increased risk of flooding during heavy rains.

Buildings: Roofs and walls of buildings are also impermeable, contributing to rapid runoff of stormwater.

Permeable Surfaces

Green Spaces: Parks, gardens and other vegetated areas have high permeability, allowing water to infiltrate into the soil. These surfaces are essential for stormwater management and reducing the urban heat island effect.

Permeable Pavements: In some areas, permeable pavement solutions have been implemented, allowing water to infiltrate, but these are still limited compared to impermeable surfaces.

The low permeability of surfaces in Chișinău contributes to drainage problems, increasing flood risks and deteriorating water quality, as rainwater flowing over impermeable surfaces can carry pollutants into drainage systems.

The analysis of surface permeability is also limited by the lack of detailed data on surface types in different areas of the city. Permeability can vary depending on weather conditions and soil moisture, and the analysis may not reflect these fluctuations. It is important to note that, in the absence of specific studies and updated data for Chișinău, the information presented can be considered as estimates and based on general knowledge.

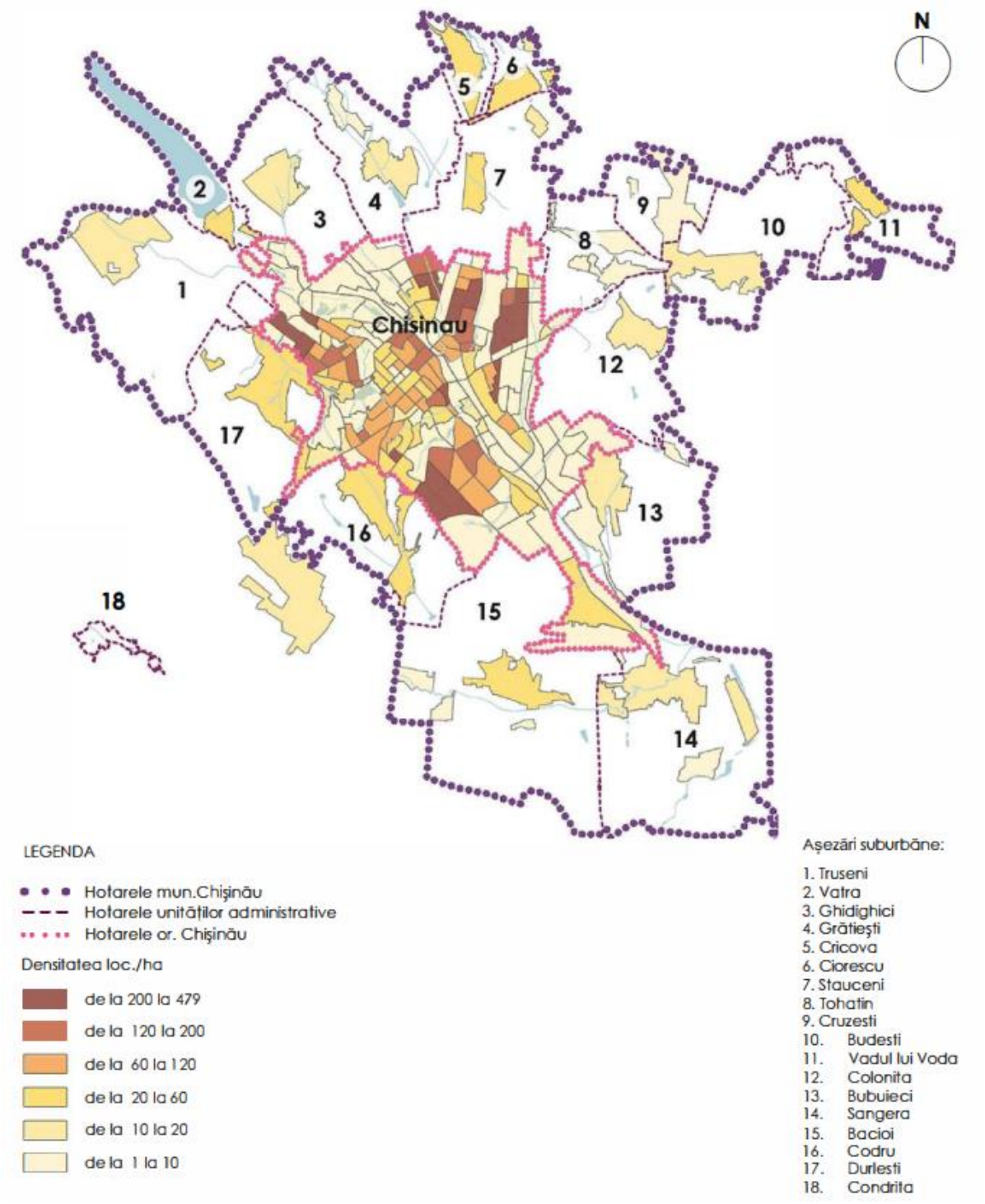
Human activities

Population density

The number of the population with usual residence in the Chișinău Municipality is around 672 thousand people, according to data from the beginning of 2023 (or 26% of the total population of the country).

The urban population of the municipality represents 90% (609.8 thousand people), and the rural population, respectively 10% (67.7 thousand people). It is worth noting that the structure of the population by area of residence has remained practically unchanged over the past eight years.

Figure 13: Population density diagram in Chișinău Municipality



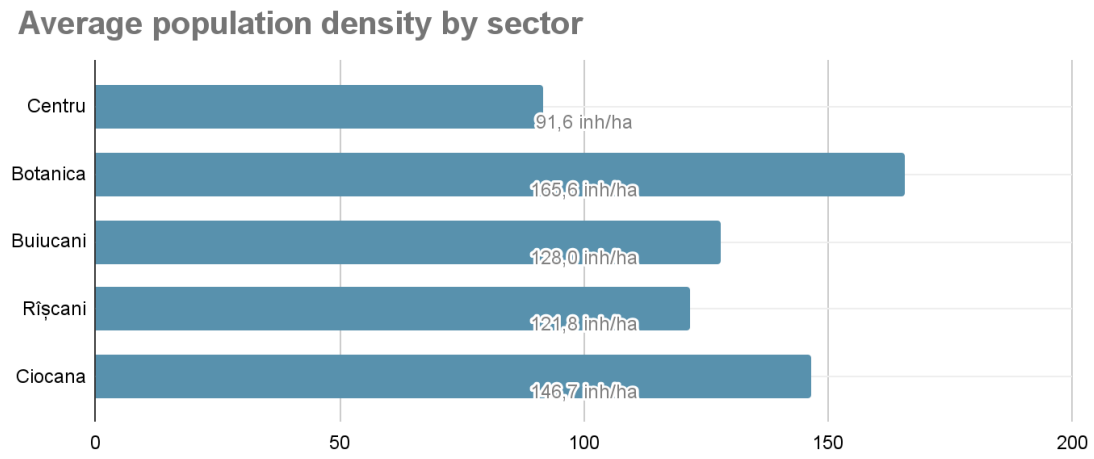
Source: Sustainable Socio-Economic and Spatial Development Strategy of Chișinău Municipality, page 66.

According to the National Bureau of Statistics, the number of residents in the capital of Moldova increased by less than 0.1% compared to the previous year, this figure is the lowest in the last five years. At the same time, the number of citizens in all sectors of the capital decreased, except for the Rîșcani sector, where the number of residents increased by almost four thousand. A significant increase is reported in the Centru sector.

The first in terms of population is the Botanică sector, followed by the Rîșcani, Ciocana, Buiucani and Centru sectors.

The population of the suburbs increased by only a hundred people, which turned out to be a statistical error, but nevertheless, it testifies to the demographic problems in the country.

Figure 14: Population density diagram in the sectors of Chișinău City



Source: Sustainable Socio-Economic and Spatial Development Strategy of Chișinău Municipality, page 69.

Land use

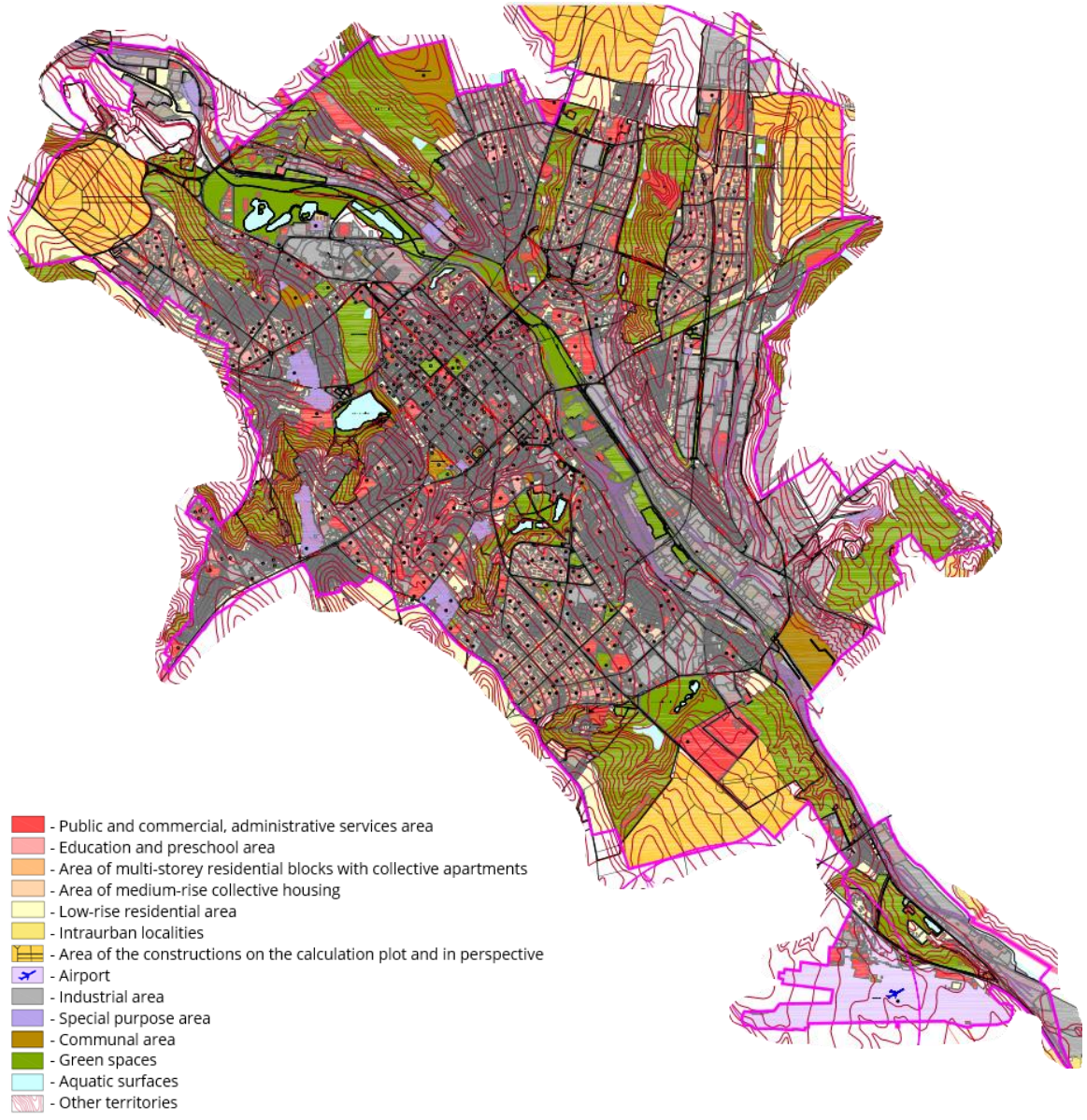
Land use in Chișinău City is a multifaceted issue that encapsulates the dynamic relationship between urban development, environmental policies, and the diverse needs of its residents. As the capital and largest city of Moldova, Chișinău has experienced significant growth and transformation over the years, leading to a complex urban landscape that requires careful management and planning.

The rapid urbanization of Chișinău has resulted in a mix of residential, commercial, and industrial zones. The city has seen an influx of population, prompting the expansion of housing developments and infrastructure. High-density residential areas have emerged, particularly in the city centre and surrounding neighbourhoods, where demand for housing is high. This growth has also led to the development of commercial spaces, including shopping centres and office buildings, which cater to the needs of a growing urban population. However, this expansion often comes at the cost of green spaces and agricultural land, raising concerns about urban sprawl and its impact on the environment.

In response to the challenges posed by urbanization, Chișinău has implemented various environmental policies aimed at promoting sustainable land use. These policies focus on

preserving green spaces, improving air quality, and managing waste effectively. Initiatives to create parks and recreational areas are essential for enhancing the quality of life for residents and providing ecological benefits. Additionally, the city has been working on improving public transportation to reduce traffic congestion and lower carbon emissions, which is crucial for maintaining a healthy urban environment.

Figure 15: Land use in Chișinău City



Source: General Urban Plan of Chișinău City

In Chișinău, land use patterns reveal significant insights into energy consumption across various sectors. The largest energy consumers are predominantly found in industrial areas, which are characterized by high-density manufacturing and production activities. These zones not only

contribute to the city's economic output but also account for substantial energy demands due to their operational requirements.

Additionally, hospitals and healthcare facilities represent another critical category of energy consumers. These institutions require continuous energy supply for medical equipment, lighting, heating, and cooling systems to ensure optimal patient care and operational efficiency.

The map of Chișinău (Figure 15) highlights these energy-intensive areas, emphasizing the need for targeted energy management strategies. By focusing on the largest consumers, such as industrial zones and healthcare facilities, the city can implement measures to enhance energy efficiency, promote sustainable practices, and reduce overall energy consumption, thereby contributing to a more resilient urban environment.

SENSITIVITY OF EQUIPMENT AND MATERIALS

Albedo (Reflectivity) Coefficient

The analysis of the albedo coefficient and vulnerability indicators in Chișinău provides a clear picture of the impact of urbanization on the Urban Heat Island phenomenon. At the same time, some data on specific temperatures in different areas of the city may be incomplete or inaccurate, and the albedo coefficient varies depending on the season.

The albedo coefficient for Chișinău is estimated to be around 0.20 - 0.25. This means that approximately 20-25% of solar radiation is reflected back into the atmosphere, while the rest is absorbed, contributing to the increase in local temperatures. This average value is influenced by the types of surfaces prevalent in the city, such as buildings, roads and vegetation.

Table 5: Indicators for evaluating the Albedo coefficient in Chișinău City

Indicator	Score	Justification
Building Density	4/5	High density in central areas
Vegetation Cover	2/5	Low percentage of vegetation
Type of Construction Material	3/5	Most materials have low albedo
Human Activities	4/5	Intense commercial activities
Transport Infrastructure	3/5	High density of the transportation network
Accessibility of Green Spaces	2/5	Relatively limited access to parks and green spaces
Socio-Economic Conditions	3/5	Moderate average income, variable education
Environmental Policies	3/5	Existing policies, but inconsistent implementation
Community Awareness	2/5	Low degree of citizen information

Source: Made by the author based on empirical observations

Using data and graphs, the most vulnerable areas were identified and effective solutions can be proposed to reduce the negative effects of UHI. This assessment highlights the importance of an integrated and collaborative approach in managing environmental issues in the city.

In Chișinău, certain areas are more vulnerable to the UHI effect due to the high density of buildings, lack of vegetation, and heat-retaining construction materials. Here are some of the most affected areas:

City Centre: This area has a high density of commercial and residential buildings, with few green spaces. Due to intense commercial activities and traffic, temperatures are significantly higher.

Buiucani District: This district has rapid urban development, with many apartment buildings and few green areas, which contributes to rising temperatures.

Rîșcani District: Similar to Buiucani, Rîșcani has a high density of buildings and low vegetation cover, which makes it vulnerable to UHI.

Industrial Zone: Industrial zones in Chișinău, such as those near Tighina Street, have a high density of buildings and economic activities, generating additional heat.

Botanica District: Although it has some green spaces, the density of buildings and the use of heat-retaining construction materials contribute to the UHI effect.

Figure 16: Thematic map highlighting the areas most vulnerable to the UHI effect

Source: www.gislocal.md

- Areas with high building density (marked in red)
- Areas with low vegetation cover (marked in yellow)
- Areas with intense commercial activities (marked in blue)

Thermal Conductivity

Thermal conductivity refers to the ability of a material to conduct heat. This is an important factor in the analysis of the Urban Heat Island effects, as materials with high thermal conductivity can retain heat, contributing to an increase in local temperatures.

In Chișinău, thermal conductivity varies depending on the type of material used in construction and the characteristics of the soil.

Construction Materials

Concrete: Thermal conductivity of approximately 1.4 - 1.8 W/m·K.

Asphalt: Thermal conductivity of approximately 0.5 - 0.7 W/m·K.

Soil: Thermal conductivity of approximately 0.5 - 1.0 W/m·K, depending on humidity.

Grass and Vegetation: Low thermal conductivity, around 0.1 - 0.2 W/m·K.

Impact on the Urban Environment

Materials with high thermal conductivity, such as concrete and asphalt, contribute to the accumulation of heat during the day and its release at night, which aggravates the UHI effect. In contrast, green surfaces and vegetation help to maintain lower temperatures.

Table 6: Thermal Conductivity evaluation indicators in Chișinău City

Indicator	Score	Justification
Type of Construction Materials	4/5	Predominance of highly conductive materials
Vegetation Coverage	2/5	Low percentage of vegetation
Building Density	4/5	High density in central areas
Human Activities	4/5	Intense commercial activities
Transport Infrastructure	3/5	High density of the transport network

Source: Made by the author based on empirical observations

The analysis of thermal conductivity in Chișinău is limited by the lack of accurate and up-to-date data on the types of materials used in construction in different areas of the city. Also, thermal conductivity can vary depending on weather conditions and soil moisture. The limitations of the analysis emphasize the importance of collecting accurate and up-to-date data to support urban planning decisions.

Heat Capacity

The thermal capacity of materials in Chișinău plays a key role in urban heat management and influencing local temperatures. This refers to the amount of heat required to change the temperature of a material and is an important factor in analysing the effects of the UHI. In

Chișinău, the predominance of building materials with high thermal capacity contributes to the accumulation of heat during the day and its release at night.

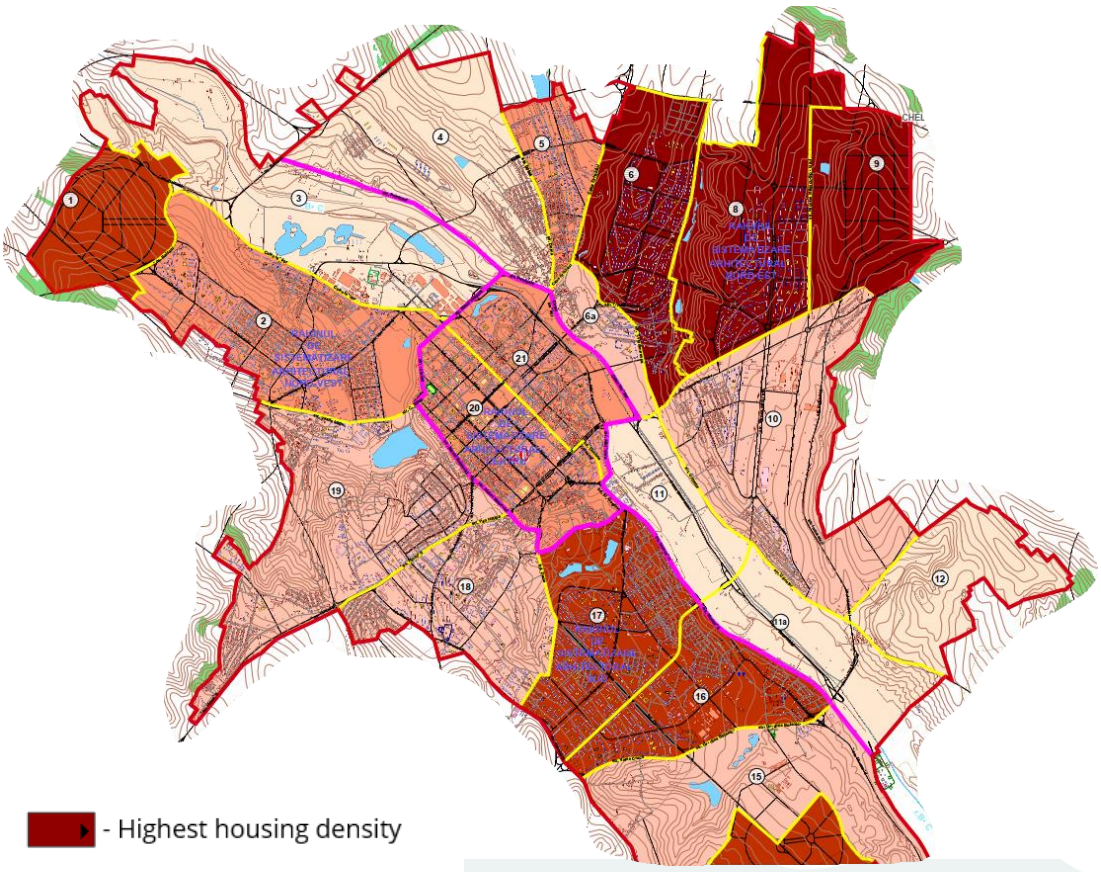
Table 7: Heat Capacity of Materials

Type of Materials	Heat Capacity	Use
Concrete	0.84 - 1.0 MJ/m³·K	Widely used in building and infrastructure construction
Asphalt	0.9 - 1.1 MJ/m³·K	Used for roads and parking lots, contributing to heat accumulation
Soil	1.0 - 1.5 MJ/m³·K (depending on humidity)	Used in traditional construction and urban gardens
Grass and Vegetation	0.5 - 0.7 MJ/m³·K	Green spaces that help cool the urban environment

Source: Made by the author based on empirical observations

Materials with high thermal capacities, such as concrete and asphalt, help to trap heat during the day, leading to higher night time temperatures. This exacerbates the Urban Heat Island effect, making the city warmer than surrounding rural areas. Green surfaces, with a lower thermal capacity, help to maintain lower temperatures by evaporating water and soil moisture, having a cooling effect on the urban environment.

Figure 17: Urban density map. Housing density

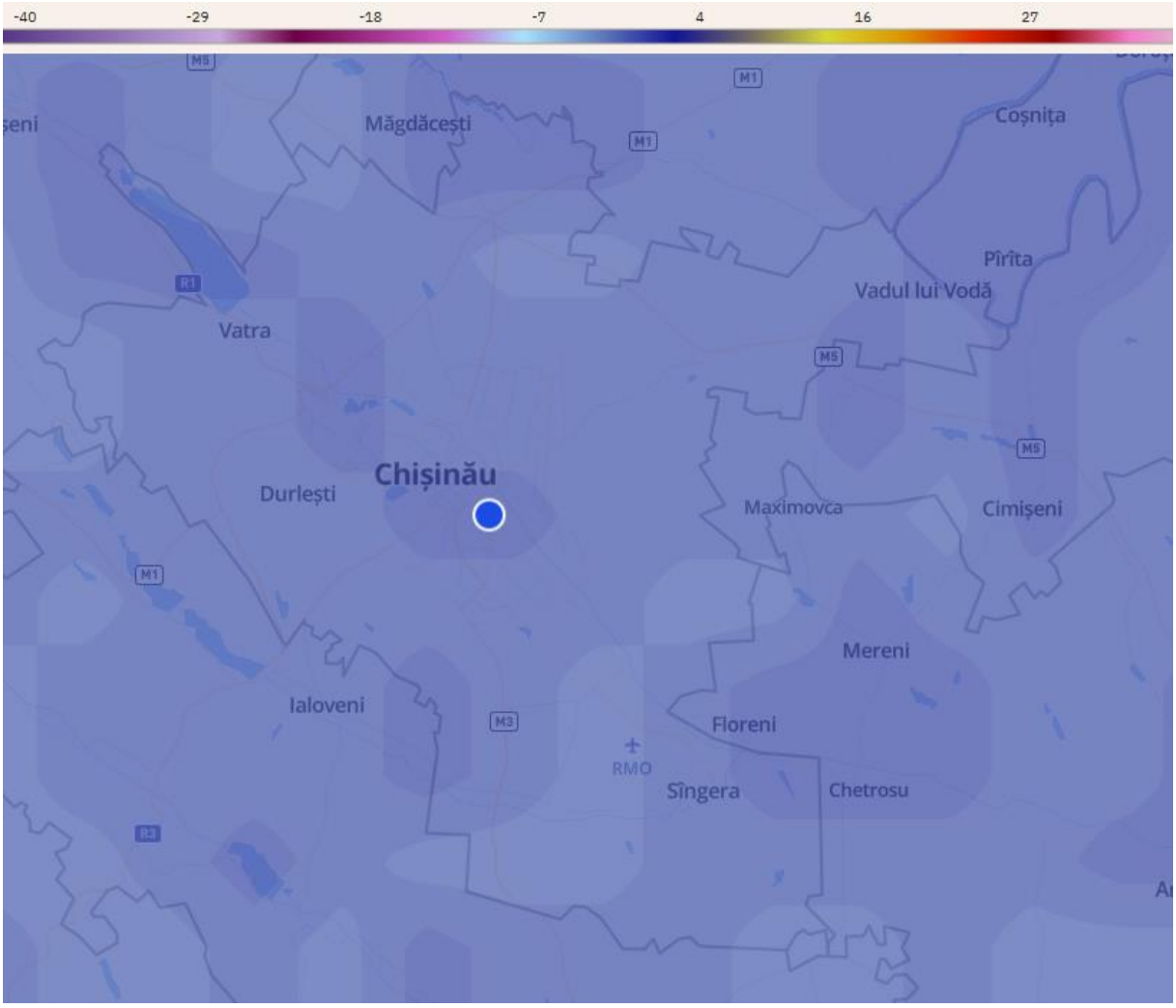


Surface Temperature

In Chișinău, surface temperature is influenced by several factors, including urbanization, types of building materials, vegetation cover, and human activities.

Surface temperature in Chișinău varies seasonally. During the summer, temperatures can reach 30°C or more, while in the winter, temperatures can drop below 0°C. However, in areas with high building density and low vegetation cover, surface temperatures can be 5-10°C higher than in areas with abundant vegetation.

Figure 18: Radar map for Chișinău Municipality



Source: www.weather.com

The map displays the surface temperature of Chișinău Municiplaity. Based on the observations, surface temperatures appear to be lower in the north-west and south-east of Chișinău, and warmer towards the east. The map shows that surface temperature vary significantly in different areas of Chișinău, due to factors like urbanisation, building materials, vegetation cover and human activities.

Limitations in Data Availability for Sensitivity Analysis

In conducting the sensitivity analysis of equipment and materials in Chișinău, significant limitations have emerged due to the lack of available data. Specifically, there are no accessible datasets from the Copernicus, CORINE Land Cover, and other European open sources reflectance for Moldova.

Furthermore, the city authorities of Chișinău do not have a dedicated enterprise or authority responsible for gathering data on the condition and characteristics of equipment and materials used within the urban environment.

As a result of these data gaps, critical indicators such as emissivity, material condition, coverage area, and vegetative cover could not be included in this study.

The absence of comprehensive data restricts the ability to fully assess the sensitivity of urban materials and their contributions to the Urban Heat Island effect, highlighting the need for improved data collection and monitoring practices in the future. Addressing these limitations will be essential for developing effective strategies to mitigate the impacts of urbanization on local climate conditions.

VULNERABLE GROUPS

Socio-economic indicators

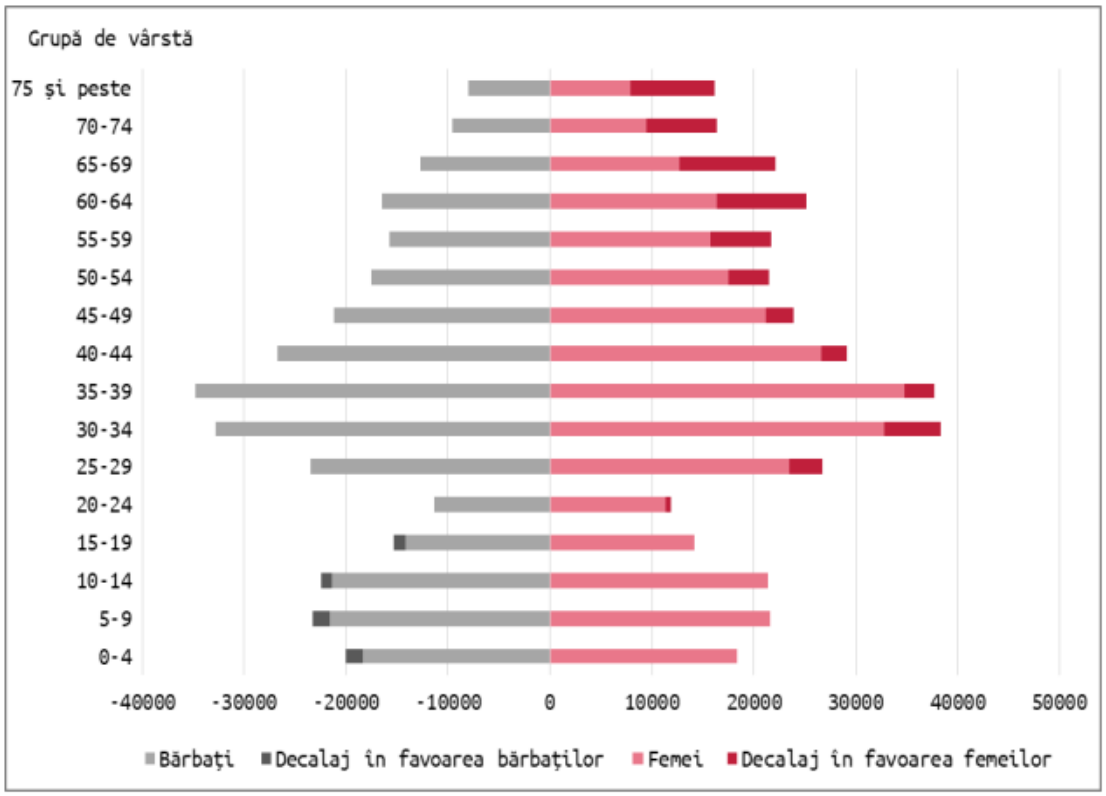
Population structure

Chișinău Municipality is an administrative-territorial unit of the Republic of Moldova, which includes the city of Chișinău - the largest city in the country, and 6 other cities and 28 villages. In total, the population of the municipality is 677.5 thousand (or 26% of the total population of the country). The urban population of the municipality accounts for 90%.

Chișinău Municipality is distinguished by high shares of young people and the working-age population. In dynamics, the analysis of the population by large age groups (children/youth, adults and the elderly) reveals a change in the structure to the detriment of the adult population.

At the beginning of 2022, the young population (0-19 years) makes up 23% of the total population of the municipality, the share of this category increased by 1 p.p. compared to 2014. The adult population (20-64 years old) represents 64% of the total, 5 p.p. less compared to 2014. Respectively, in the age structure of the population, the share of the elderly (65 years old and over) increased from 9% to 13%.

Figure 19: Population with usual residence in Chișinău municipality by age and sex, beginning of 2022, people



Source: "Demographic profile of Chișinău municipality", Independent Analytical Center Expert-Grup, Chișinău 2022

The age and gender structure of the population of Chișinău municipality at the beginning of 2022 reflects an uneven profile (Figure 19). Analysing the population pyramid by five-year age groups, the small number of the population aged 15-19 and 20-24 stands out, a situation that illustrates the consequences of external migration processes. At the same time, it is noted that the number of children aged 0-4 is also low compared to the other categories.

On the other hand, the number of people aged 35-39, born in the 1980s, is relatively high, both due to the family policies promoted at that time and the large generation of their parents. The share of the working-age population (20-64 years for men and 20-59 for women) represents 65% of the total population, which means that Chișinău municipality has a high labour force rate (demographic dividend).

Young people

During the period 2015-2024, Chișinău witnessed significant changes in its demographic structure, especially among young people aged 15 to 34. This age group is crucial for the development of the city, having a profound impact on the local economy, education and culture.

Analysing the data in the Table below, we can observe the trends and challenges faced by young people in Chișinău.

Table 8: Number of populations with usual residence and share of young people in the age group 15-34, by gender, Chișinău municipality, at the beginning of 2021-2024

	2021			2022			2023			2024		
	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female
Total population, people	669,758	308,061	361,697	671,667	308,238	363,429	670,062	306,094	363968	665461	302566	362895
Young people 15-34 years old, people	178,468	84,980	93,488	171,588	81,588	90,000	163,362	77,269	86,093	155587	73466	82121
Share of young people, 15-34 years old, %	26.6	27.6	25.8	25.5	26.5	24.8	24.4	25.2	23.7	23.4	24.3	22.6

Source: NBS

Youth Population

In the early years of the analysis, the number of young people in Chișinău registered a steady increase. This expansion can be attributed to factors such as the high birth rate in previous years and the city's attractiveness to young people due to its educational and job opportunities. However, starting in 2018, signs of stagnation were observed, and in the following years, a slight decrease in the number of young people became evident. This trend can be explained by the migration of young people in search of better opportunities abroad, but also by the economic challenges facing the country.

Gender Share

An important aspect to mention is the gender share of young people. The data shows a predominance of women in this age group, which may reflect not only demographic but also social aspects. Young women tend to focus more on education and career, which gives them an advantage in the labour market. This gender discrepancy can also influence the social and economic structure of the city, with implications for youth policies and support programs.

Impact on Society

Fluctuations in the number of young people in Chișinău have a significant impact on society. An active young population is essential for innovation and economic development. Young people contribute to the diversification of the labour market and the revitalization of local communities. However, a decrease in their numbers can lead to an aging population and a smaller labour force, which can negatively affect the city's economy.

Elderly people

At the beginning of 2022, 84.9 thousand people aged 65 and over lived in the municipality of Chișinău (24 thousand people more compared to 2014), of which 36% were men and 64% were

women (Table 9). The population aging coefficient was 13 people aged 65 and over per 100 inhabitants. Among men, this coefficient is 13, and among women it was higher - 15 women aged 65 and over per 100 women.

Table 9: Population aging indicators (usually resident population) at the beginning of 2014-2022

	2014	2015	2016	2017	2018	2019	2020	2021	2022
People aged 65 and over, thousands of people	60,9	64,5	67,8	71,1	74,4	77,2	80,7	83,3	84,9
Men	23	24	25	27	28	29	30	30	30
Women	38	40	42	44	47	49	51	53	55
Population aging rate (people aged 65 and over per 100 inhabitants)	9	10	10	11	11	12	12	12	13
Men	7	8	8	9	9	9	10	10	10
Women	11	11	12	12	13	14	14	15	15

Source: Idem

Natural population growth

According to data from the National Bureau of Statistics, from 2014 to 2019 (inclusive), the natural population growth in Chișinău was positive, with the number of live births exceeding the number of deaths (Table 10). However, in 2020 and 2021, due to the decrease in the number of live births and the increase in the number of deaths, the natural population growth recorded negative values. Moreover, the negative growth in 2021 was more pronounced than in 2020, being 1,559 people higher. Per 1,000 inhabitants, the number of births was 9, and the number of deaths was 12, reflecting both the aging and migration processes, as well as the effects of the Covid-19 pandemic.

Table 10: Natural movement of the population with usual residence, persons

Years	Born alive	Deceased	Natural growth
2014	7 421	5 618	1 803
2015	7 216	5 781	1 435
2016	7 398	5 657	1 741
2017	6 804	5 514	1 290
2018	6 696	5 703	993
2019	6 621	5 428	1 193
2020	6 489	7 054	-565
2021	6 195	8 319	-2 124

Source: Idem

Mortality rate

According to preliminary data published by the National Bureau of Statistics, in the municipality of Chișinău the mortality rate for the years 2020-2021 was 12.6 per 1,000 people, being higher compared to the years before the Covid-19 pandemic. The data suggests that the Covid-19 pandemic has most affected mortality among people in the age category 65 and over, and the category 50-64, both among men and women.

Absolute poverty rate

The absolute poverty rate is an essential indicator for assessing the standard of living of the population and the economic conditions in a region.

During the period 2014-2022, according to the table below, Chișinău municipality experienced fluctuations in terms of this indicator, reflecting both economic developments and the social policies implemented.

Table 11: Absolute poverty rate in Chișinău municipality, at the beginning of 2014-2022

Years	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Absolute poverty rate	10.7	6.9	6.5	7.5	4.7	4.4	7.6	8.6	10.0	10.9

Source: Idem

In the period 2014-2016, the absolute poverty rate was relatively high, influenced by the regional economic crisis and political instability. Social support measures were insufficient to counteract the negative effects on the vulnerable population.

In the period 2017-2019, a slight decrease in the poverty rate was observed, due to economic growth and the implementation of more effective social assistance programs.

In the period 2020-2022, the COVID-19 pandemic had a significant impact on the economy, causing a temporary increase in the poverty rate. However, economic recovery measures and government support helped stabilize the situation, and the poverty rate started to decrease again.

Unemployment Rate

Analysing statistical data on the ILO unemployment rate (unemployment rate according to International Labour Organization - ILO standards) in Chișinău for the period 2014-2023, we observe an evolution that reflects both the dynamics of the local labour market and the impact of external economic and social factors.

Table 12: Unemployment rate in Chișinău municipality, at the beginning of 2014-2023

Years	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
ILO unemployment rate, %	3.6	4.0	4.2	5.8	4.8	4.6	3.8	3.2	3.7	4.2

Source: Idem

In 2014, the unemployment rate in Chișinău was 3.6%, suggesting a period of relative stability in the labour market in the city. This reflects moderate economic development, with constant demand on the labour market and relatively good availability of jobs in various sectors. However, in the following two years, the unemployment rate recorded a slight increase, reaching 4.0% in 2015 and 4.2% in 2016. This trend can be attributed to internal factors, such as economic restructuring or difficulties encountered by certain local industries, but also to external factors that influenced the national and local economy.

The year 2017 marked a significant jump in the unemployment rate, reaching 5.8%. This steep increase can be explained by a number of factors, including domestic and regional economic uncertainties, fluctuations in the national economy and the impact of economic crises in other states. Also, the political crisis and social instability at the national level could have negatively influenced the creation of new jobs and, implicitly, their availability on the labour market in Chișinău.

During 2018-2019, Chișinău municipality registered a slight stabilization, with a decrease in the unemployment rate to 4.8% in 2018 and to 4.6% in 2019. This may reflect a partial recovery of the municipal economy, stimulated by employment support measures and the growth of key economic sectors, such as trade and services. It is also possible that the implementation of vocational training and continuing education programs contributed to the improvement of the employment rate in Chișinău.

In 2020, following the crisis caused by the COVID-19 pandemic, the municipality of Chișinău recorded a decrease in the unemployment rate to 3.8%, which may seem paradoxical given the negative economic effects of the pandemic. However, this decrease could be explained by government interventions aimed at supporting the forced short-term employment of employees in the affected sectors and the relocation of a large number of jobs in the digital and online services field.

During the period 2021-2023, the unemployment rate experienced a stabilization trend. In 2021, it reached 3.2%, which suggests a gradual economic recovery and an increase in confidence in the labour market in Chișinău. However, in 2022 and 2023, the unemployment rate fluctuated slightly, reaching 3.7% in 2022 and 4.2% in 2023, indicating continued economic volatility and possible difficulties in certain sectors, such as retail or tourism, affected by international economic crises and changes in the labour market.

Overall, the analysis of the evolution of the unemployment rate in Chișinău municipality between 2014 and 2023 highlights a complex dynamic, influenced by multiple internal and external economic variables. Although fluctuations have been recorded, a general trend of recovery and adaptation to new economic conditions can be observed. However, challenges related to structural changes in the labour market, digitalization and external economic crises continue to affect the evolution of the unemployment rate in Chișinău, and economic policy measures must

remain flexible and adaptable to support the development of a sustainable labour market in the long term.

Migration processes and emigration intentions

The City of Chișinău, being the main economic centre of the country, but also the other localities within the municipality due to their geographical proximity to the capital, attract people from other localities of the country.

In 2021, the municipality of Chișinău recorded a positive increase in internal migration of 12.5 thousand people. The largest number of people who decided to change their place of residence, settling in the localities within the municipality of Chișinău, are from the working age group – 7,701 people, followed by young people – 4,500, and obviously, the smallest number is characteristic of the elderly – 271 people.

Table 13: Net internal migration of Chișinău municipality by major age groups and areas of residence

	2017		2018		2019		2020		2021	
	urban	rural	urban	rural	urban	rural	urban	rural	urban	rural
Total	8 306	439	10 268	706	12 362	975	10 387	620	11 763	709
0-19 years	3 183	147	3 842	226	4 596	305	3 904	188	4 271	229
20-64 years	4 938	280	6 222	447	7 623	640	6 375	417	7 259	442
65 years and more	185	12	204	33	143	30	108	15	233	38

Source: Idem

Within the age groups, youth is the most mobile within the country (51.0%), a fact explained by continuing studies, separation from parents or starting a family. Among the elderly, only 6.8% reported changing their residence address.

Emigration is a specific process for the Republic of Moldova, including for the municipality of Chișinău. As a result of external migration processes, over ten thousand people leave the municipality of Chișinău annually. In 2020, the number of emigrants decreased, contributing to the negative growth of external migration, but this is mainly due to travel restrictions caused by the Covid-19 pandemic, and not to the cessation of emigration intentions.

Table 14: Net external migration by major age groups, persons

	2014	2015	2016	2017	2018	2019	2020
Total	-12 066	-13 507	-16 488	-15 440	-13 313	-10 117	-2 552
0-19 years	-3 891	-4 237	-4 220	-4 116	-4 874	-4 291	-2 307
20-64 years	-7 903	-8 878	-11 840	-10 971	-8 284	-5 546	-456

65 years and more	-272	-392	-428	-353	-155	-280	211

Source: Idem

Age is an important factor determining intentions to emigrate. Thus, 35.5% of young people in the municipality intend to leave the country, as well as 22.0% of the working-age population. At the same time, the most determined to emigrate are the self-employed – 34.9% and the unemployed – 33.3%.

Labour market

According to NBS data, the number of employees in the municipality of Chișinău recorded about 356 thousand people in 2021 (Table 15).

The average gross salary of women in the municipality of Chișinău amounted to 9,898 lei, being 1,545 lei higher than the gross salary of women calculated at the national level.

The average gross salary of men amounted to 12,027 lei, 2,354 lei higher than the average gross salary of men calculated at the national level. Men's salary constantly exceeds that of women, and the gap deepens from year to year, which speaks to the need to combat gender pay inequality.

Table 15: Number of employees and gross salary, in dynamics 2014-2021

	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
	Number of employees in Chișinău municipality (people)							
Total	347 675	346 281	347 478	346 593	359 491	359 138	356 511	356 202
	Average gross monthly salary (lei)							
Chișinău: Women	**4 535**	**4 990**	**5 447**	**6 193**	**6 865**	**7 914**	**8 651**	**9 898**
National average: Women	3 832	4 235	4 631	5 204	5 801	6 710	7 387	8 353
Chișinău: Men	**5 117**	**5 771**	**6 469**	**7 257**	**8 117**	**9 461**	**10 487**	**12 027**
National average: Men	4 375	4 881	5 414	6 017	6 779	7 808	8 559	9 673

Source: Idem

The data of the "Generations and Gender" Study show that 55.5% of the population aged 15-64 of the municipality of Chișinău is involved in paid work. Involvement in paid work/salary is higher for men than for women. The lowest level of employment in paid work is evident among young women (15-34 years old), which is explained by the reproductive period of women, and respectively the fulfilment of the tasks of raising and caring for children.

By place of residence, it is observed that women from urban areas are more frequently employed in paid work than those from rural areas. A similar situation is also observed for men. A higher level of education is associated with a higher level of involvement in paid work.

Social housing

According to the information provided by the General Directorate of Medical and Social Assistance (DGAMS) of Chișinău Municipality, the segment related to social housing falls under the competence of the General Directorate of Housing, Communal Affairs and Planning. At the same time, from the information held, it is mentioned that currently the Chișinău City Hall, as a local public authority managing the territory of Chișinău Municipality, does not have social housing.

Pensioners

According to data provided by the General Directorate of Medical and Social Assistance, as of 01.01.2024, the number of old-age pensioners in Chișinău was 127.5 thousand, out of the total population of the Municipality with habitual residence.

Health conditions

Following the official request for information addressed to the General Directorate of Medical and Social Assistance (DGAMS) of Chișinău Municipality on 05.12.2024, the official response was received on 10.01.2025, more than a month later.

According to the information presented in the respective response, DGAMS mentions that it is not the authority that ensures the centralization of data regarding the population record in terms of age, disability and diseases suffered. In case of needs for evaluation and planning of processes, the Directorate requests relevant information/data from the Public Services Agency, the Social Insurance House, the National Council for Determining Disabilities and Work Capacity or the National Agency for Public Health, as well as uses data from the National Bureau of Statistics.

Considering that all institutions and authorities referred to by DGAMS are public, and obtaining a response following an official address may take more than 30 days, there is a limitation in the availability of data in this segment.

Infrastructure

From the information provided by DGAMS, the Nomenclature of medical service providers is managed by the Ministry of Health, and the competent body for centralizing data on the health field and the state of the population is provided by the National Agency for Public Health. DGAMS is only responsible for providing methodological support to municipal medical and health institutions and submitting proposals for their organizational optimization.

Under the subordination of DGAMS, 12 hospitals operate on the territory of Chișinău Municipality, of which 9 are inpatient, with a capacity of 2575 beds, as well as 5 Territorial Medical Associations, which include 12 family doctor centres.

In the suburbs of Chișinău Municipality, 14 health centres operate, the founder of which is the local public administration authority. These suburbs are: Băcioi, Sângera, Durlești, Ghidighici, Vatra, Trușeni, Vadul lui Vodă, Cricova, Ciorescu, Bubuieci, Colonița, Budești, Stăuceni and Grătiești.

The health policies adopted at the level of Chișinău Municipality are:

- Chișinău Municipality Resilience Strategy for the period 2024-2030;

- Municipal program of financial support for medically assisted human reproduction;

- Program of compensation of treatment expenses of people without medical insurance;

- Program of providing free dairy products to children in the first year of life from disadvantaged families;

- Program of providing dental medical assistance to people from socially disadvantaged groups;

- Program of providing people with visual impairments with sound tannometers;

- Municipal program of screening for breast cancer by mammography for the year 2022-2025;

- Program for the implementation of complex measures to minimize the impact of hot temperatures on the health of the population in the municipality of Chișinău.

The municipality of Chișinău is aligned with and implements national and local policies in the areas of: prevention and combating human trafficking, prevention and combating domestic violence, protection of national minorities, protection of war veterans, social inclusion of people with disabilities.

Nursing homes

In the same vein, DGAMS informs that it does not have any placement services (nursing homes), and the official number of such services (accredited/unaccredited) on the territory of Chișinău is unknown.

In order to meet the placement needs of residents of Chișinău in difficult situations, determined by old age, health status and lack of housing space, their cases are referred to highly specialized social services in residential institutions subordinated to the Ministry of Labour and Social Protection, one of which is based in the municipality of Chișinău, namely the Placement Centre for the Elderly and People with Disabilities, which has a capacity of 210 places.

Vulnerability Analysis

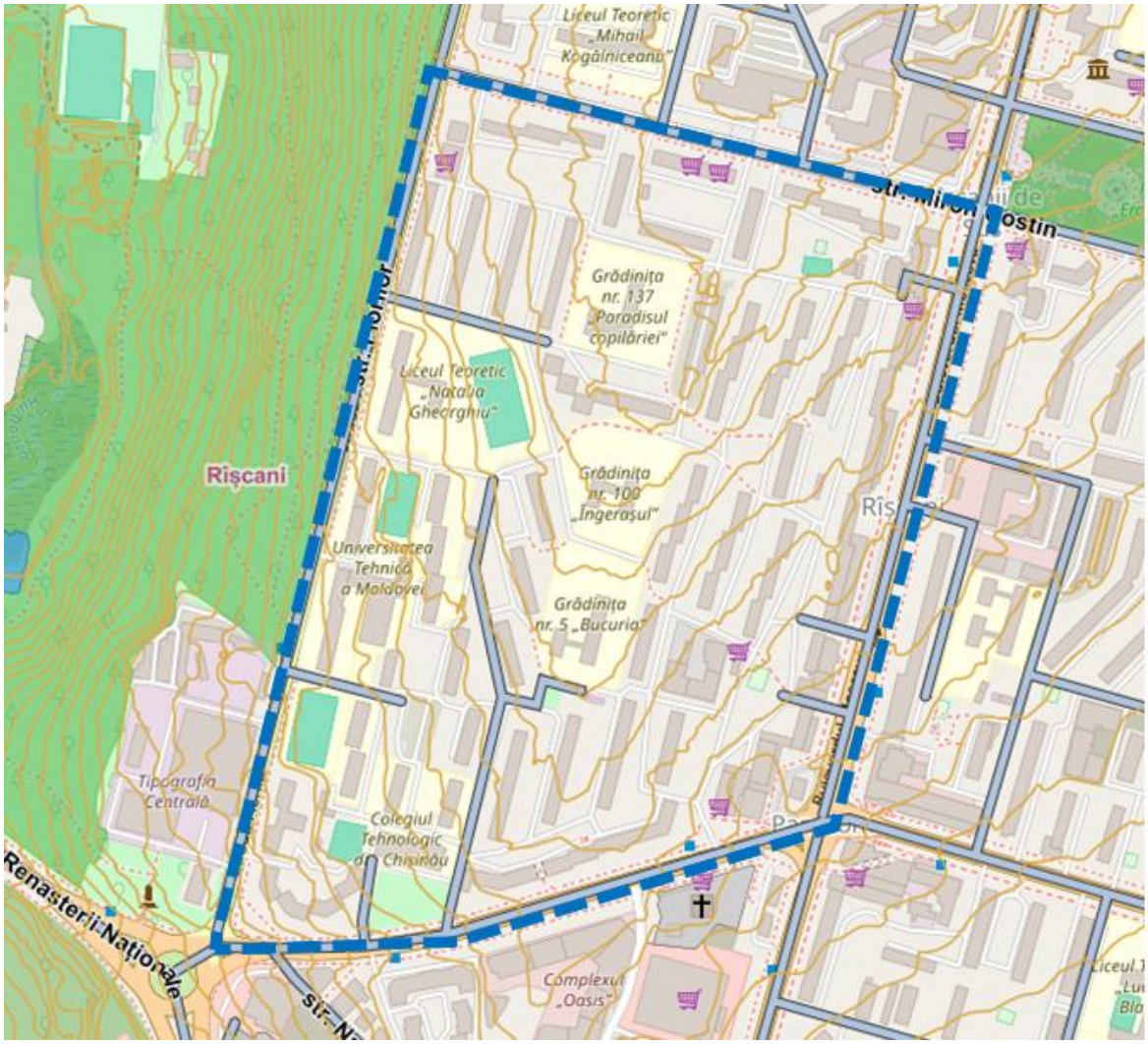
Given the actual size and population of Chișinău, along with the lack of comprehensive information and data from local authorities, it was not feasible to assess the vulnerability of the entire urban population.

Moreover, it is important to note that the current assessment was conducted during the cold period (November 2024 – January 2025) which inherently limits the ability to capture the full extent of the Urban Heat Island (UHI) effect. During this time, the temperatures are generally lower, and the thermal dynamics of the urban environment differ significantly from those experienced in the warmer months. Thus, the identification of "hotspots" where heat is

concentrated may not accurately reflect the conditions that occur during the summer, when the UHI effect is typically more pronounced. This seasonal discrepancy highlights the need for future assessments to be conducted during the summer months, when high temperatures can exacerbate the vulnerabilities of the local population, particularly among children, the elderly, and low-income residents. Such an approach would provide a more comprehensive understanding of how urban design and land use contribute to heat retention, ultimately informing more effective mitigation strategies tailored to the specific needs of the community.

Therefore, the analysis is focused on a selected neighbourhood in the Rîșcani sector (see Figure 20), following a focus group discussion organized with representatives from the local authority. This neighbourhood was chosen for its significance in the context of the planned mitigation measures within the project framework. Riscani is notably one of the most densely populated areas inhabited by vulnerable groups, including children under five, the elderly, young people, and low-income residents.

Figure 20: Map of the selected neighbourhood for vulnerability analysis



Source: www.gislocal.md

The presence of three kindergartens in the neighbourhood area (No. 5, No. 100 and No. 137) highlights the concentration of young children, who are particularly vulnerable to the effects of the Urban Heat Island (UHI) phenomenon. Elevated temperatures can lead to heat-related health issues, such as heat exhaustion and dehydration, which can significantly impact their development and well-being. Young children are less able to regulate their body temperature, making them more susceptible to the adverse effects of extreme heat, especially during the summer months when UHI effects are most pronounced.

Meanwhile, the neighbourhood's aging infrastructure, characterized by old five-story apartment blocks, predominantly houses elderly residents aged 65 and above. This demographic is also at heightened risk due to the UHI effect, as older adults often have pre-existing health conditions that can be exacerbated by extreme heat. The lack of adequate cooling systems in many of these older buildings further compounds their vulnerability, increasing the likelihood of heat-related illnesses such as heat stroke or exacerbation of chronic conditions.

Additionally, this neighbourhood is home to several student dormitories and the location of the Technological College of Chișinău and the Technical University of Moldova, indicating a significant population of young adults and individuals from lower-income backgrounds. These residents may lack access to air conditioning or other cooling resources, making them particularly susceptible to the impacts of rising temperatures.

The combination of high-density living conditions, limited access to green spaces in the area, and the UHI effect creates a challenging environment for these vulnerable groups, underscoring the urgent need for targeted interventions to mitigate heat exposure and enhance community resilience.

PREPAREDNESS AND ADAPTIVE CAPACITY OF CITIES AND MUNICIPALITIES

Institutional factors

Governance structures

The Republic of Moldova is ranked as the most vulnerable country in Europe from a climate perspective. The impact of climate change on the social, economic and environmental dimensions of the country is expected to intensify in the medium and long term. Medium-term projections indicate a continuous increase in the average annual temperature between 2010 and 2040 by 2°C. Regarding precipitation, a 13% decrease in the total annual amount is forecast, while annual flows will become more unstable with an increase in the frequency of floods.

The planning and implementation of climate change adaptation measures is a shared responsibility and requires the involvement of central public authorities, their subordinate institutions, local public authorities, the private sector and civil society. The cross-cutting aspect of climate change policy is reflected in the functions and powers of the National Commission for Climate Change, created by Government Decision no. 444/2020.

The National Commission for Climate Change is a permanent, formalized body that brings together high-level representatives from line ministries, NGOs, academia, research, the private sector and women's associations and representatives of the Congress of Local Authorities of Moldova.

The Ministry of Environment is the authority vested with the competence to develop and promote policies in the field of environmental protection, climate change, rational use of natural resources and biodiversity conservation, to identify priorities in the cross-cutting areas of environment and climate change; to develop and promote national action programs and plans that address these priorities; to coordinate relevant actions and monitor their implementation. On behalf of the Government, the Ministry of Environment is also responsible for the implementation of international treaties related to the environment and climate change to which the Republic of Moldova is a party.

The implementation of climate change policies is ensured by the institutions subordinate to the Ministry of Environment, namely: the State Hydrometeorological Service, the Environment Agency; "Moldsilva" Agency and "Apele Moldovei" Agency.

The State Hydrometeorological Service is a public institution whose main tasks are to monitor the state and evolution of hydrometeorological conditions in the country; to develop meteorological, hydrological and agro-meteorological forecasts; to issue alerts regarding the imminence of dangerous hydrometeorological phenomena; to provide hydrometeorological information to the population, central and local public authorities, enterprises and emergency services.

The Environment Agency has key functions regarding monitoring the quality of environmental components (air, water, soil), issuing environmental permits, managing environmental information and reporting, developing reports on the state of the environment, ensuring the implementation of the monitoring, verification and reporting system for GHG emissions, ensuring the process of collecting, validating and processing the data and information necessary for inventories and reports on air pollutants and GHG emissions, providing technical support for the development of national communications, updated biennial reports and biennial transparency reports, accompanied by national inventory reports as a technical annex, in accordance with the provisions of the UNFCCC. The EA is designated as the national authority responsible for the management and operation of the National Monitoring and Reporting System of GHG emissions and other information relevant to climate change.

In terms of information and data processing – the National Bureau of Statistics (NBS) is the institution that has the mission to collect, process and disseminate objective, reliable and timely statistics, necessary for the decision-making process, research, forecasting and general information of society. In terms of environmental indicators, the NBS provides information on the following categories: atmospheric air protection; land and forest fund; meteorology (temperature, precipitation and wind speed); waste management; use of water resources. The annual statistical report contains annual information that may be relevant for the CCA (for example on water and forest resources, changes in temperature and precipitation).

The Ministry of Education and Research supports the country's policy in the field of climate change (including CCA) by promoting dedicated educational programs, scientific studies and research programs.

The National Agency for Research and Development under the Ministry of Education and Research (GD no. 196/2018) is responsible for implementing the national research, innovation and development policy of the EU Framework Programme for Research and Innovation Horizon 2020, as well as for coordinating with the Moldovan Office for Science and Technology in Brussels. Thus, both the NARD and the specialized institutes of the Academy of Sciences of Moldova are well placed to promote specific climate-related topics in research and innovation projects at national and international level. However, as the SNASC 2020 evaluation concluded, the lack of active involvement of national scientific and research institutions remains a substantial gap in the institutional arrangements for implementing climate change policy (especially with regard to the necessary technological innovation).

In terms of horizontal governance, the Ministry of Finance plays a key role in the country's adaptation planning, as all national and sectoral priorities are defined and implemented through specific budget allocations that can facilitate the integration of CCA into actions at different levels of government.

Normative and regulatory framework

At the national and city levels, there is no regulatory framework for the effects of the urban heat island. For this reason, the existing normative and regulatory framework for climate change adaptation, which contains aspects related to the effects of UHI, will be studied.

The main strategic framework for climate change adaptation in Moldova was provided by the National Strategy for Climate Change Adaptation 2014-2020 and the Action Plan for its implementation (approved by GD 1009/2014) whose main objectives were oriented towards increasing the country's capacity to adapt and respond to the current or potential effects of climate change. SNASC 2020 served as an umbrella strategy, which established a favourable environment for the government and local public authorities to integrate climate change adaptation and risk management into existing and future policy documents through a series of sectoral actions at the national and local levels.

The regulatory framework in the field of climate change adaptation includes:

• Law No. 78/2017 on the ratification of the Paris Agreement. The Paris Agreement explicitly addresses the establishment of a global objective of "increasing adaptive capacity, strengthening resilience and reducing vulnerability to climate change in order to contribute to sustainable development". The Republic of Moldova submitted to the UNFCCC its 4th National Communication in 2018 and its updated Nationally Determined Contribution in 2020. Both documents contain adaptation components, which are based on the experience gained from the implementation of the first Strategy of the Republic of Moldova on Adaptation to Climate Change by 2020 and the Action Plan for its implementation. National Strategy on Adaptation to Climate Change and Action Plan (NAP-1).

• Government Decision No. 1277/2018 on the establishment and operation of the National System for Monitoring and Reporting of Greenhouse Gas Emissions and Other Information Relevant to Climate Change;

• Government Decision No. 444/2020 on the establishment of the mechanism for coordinating activities in the field of climate change.

Regarding disaster risk management, a Master Plan for Flood Risk Prevention was developed in 2016 with the assistance of the European Investment Bank. Consequently, flood risk management plans were adopted for the two River Basin District Management Plans 2022-2027 (GD No. 562/2020).

In line with the United Nations Convention to Combat Desertification, Moldova developed the National Action Plan to Combat Desertification in 2000, introducing measures aimed at minimizing the consequences of desertification and drought. In 2019, with the aim of creating a coordinated and comprehensive framework with integrated actions to reduce drought risk and improve drought preparedness based on adaptation and resilience perspectives, the National Drought Plan was developed.

At the sectoral level – adaptation plans were developed for the forestry and health sectors, and integration options for the energy and transport sectors were developed during the NAP-1 process. Although not formally adopted, these tools facilitated the integration of CCA measures into the sectoral planning process.

At local level – most districts and localities have socio-economic development plans, in which some activities and targets could be affiliated with climate change adaptation. 21 localities have submitted sustainable energy and climate action plans, which are supported by the Covenant of Mayors; however, climate change adaptation is not explicitly addressed, as the LPAs involved in promoting relevant activities do not have sufficient knowledge and experience in the field.

Policies and plans

Climate change adaptation aspects were found directly and indirectly in the following policy documents at the country level:

• Environmental Strategy for 2014-2023 and the Action Plan for its implementation, approved by Government Decision no. 301/2014);

• Low-Emission Development Strategy of the Republic of Moldova until 2030 and the Action Plan for its implementation, approved by Government Decision no. 1470/2016;

• Program for the Promotion of the "Green" Economy in the Republic of Moldova for 2018-2020 and the Action Plan for its implementation, approved by Government Decision no. 160/2018;

• National Strategy for Agricultural and Rural Development for 2014-2020 and the Action Plan for its implementation, approved by Government Decision no. 742/2015;

• Program for the conservation and enhancement of soil fertility for the years 2011-2020, approved by Government Decision no. 626/2011;

• Program for land improvements to ensure sustainable management of soil resources for the years 2021-2025 and the Action Plan for its implementation 2021-2023, approved by Government Decision no. 864/2020);

• Strategy for sustainable development of the national forestry sector, approved by Government Decision no. 739/2003;

• Energy Strategy of the Republic of Moldova until 2030 approved by Government Decision no. 102/2013;

• National Health Policy, approved by Government Decision no. 886/2007;

• Health System Development Strategy for the period 2008-2017 and the Action Plan for its implementation, approved by Government Decision no. 1471/2007;

• National Public Health Strategy for the years 2014-2020, approved by Government Decision no. 1032/2013;

According to point 4 of Government Decision no. 386/2020 on the planning, development, approval, implementation, monitoring and evaluation of public policy documents, policy documents that do not comply with its provisions remain enforceable until the end of the implementation period, but no more than 2 years from the entry into force of the respective decision. Thus, in sectors vulnerable to climate change, new public policy documents are being developed that will include measures that will increase resilience to climate change.

Social factors

The adaptive capacity of a city, such as Chișinău, depends to a large extent on the social factors that support the community in the face of changes and challenges. These factors include social connections, community cohesion, the capacity for self-learning and self-organization of communities, as well as the skills and knowledge available among residents. All of these indicators play an essential role in the process of adapting to new economic, social, political or environmental conditions.

Social connections

Social connections are the networks of relationships between individuals and groups that allow for the exchange of information, resources, and mutual support. In the context of Chișinău, these connections are essential for the city's resilience and adaptability. For example, volunteer networks, local support groups, and non-governmental organizations play a significant role in supporting the community in the face of crises or economic changes.

The Republic of Moldova, and Chișinău in particular, also went through a period of political instability, marked by protests and frequent government changes. These political crises had an impact on the economy and contributed to the continued migration of citizens from Chișinău and across the country, in search of better economic opportunities in business or in other countries. This phenomenon had a significant impact on the social structures of Chișinău, with many young people and families leaving for business or to study abroad.

During this period, social connections in Chișinău were essential for maintaining ties between those who emigrated and those who stayed home. Many communities in Chișinău have used online platforms to stay in touch and support the economic development of the region by sending financial remittances or implementing joint projects between those in the diaspora and those in the country. Non-governmental organizations in Chișinău have also been very active in supporting those affected by forced migration, providing counselling and social assistance to families left behind.

Community cohesion

Community cohesion refers to the degree to which members of a community are united and collaborate for the common good. In Chișinău, community cohesion can be observed through various local initiatives, such as urban revitalization projects or the organization of cultural events that bring together different social groups, as well as the crises that have occurred.

For example, neighbourhoods where there is active cultural activity, such as Valea Morilor Park or the Great National Assembly Square, tend to have greater cohesion, and residents are more willing to get involved in collective actions, such as public cleaning or environmental protection.

The COVID-19 pandemic has been one of the biggest crises that Chișinău and the entire country have recently faced. During the period of isolation, social connections and community cohesion have played a crucial role in supporting the vulnerable. Many organizations and volunteer groups have quickly mobilized to support the elderly or those who did not have access to the necessary resources. For example, in Chișinău, local support networks were formed to deliver food and medicine to people in quarantine or isolation. This mobilization demonstrated the community's ability to create rapid and effective connections in the context of a global crisis.

Self-learning/self-organizing capacities of communities

Self-learning and self-organization are essential capacities that allow communities to adapt quickly and effectively to external changes.

A significant example of social adaptation through self-learning and self-organization was given by the Ukrainian refugee crisis, which began in 2022, following the Russian invasion of Ukraine. Chișinău became a crossing point and a place of shelter for thousands of Ukrainian refugees fleeing the war. The rapid mobilization of the community, authorities and non-governmental organizations was essential in ensuring adequate support for these refugees. Volunteer networks and local support groups provided accommodation, food, medical assistance and counselling for the refugees, and the citizens of Chișinău were actively involved in this mobilization. This solidarity demonstrated the power of social connections, community cohesion, marked by rapid self-organization in the face of a large-scale humanitarian crisis.

Available skills and knowledge

The skills and knowledge available among the inhabitants are also determining factors of Chișinău's adaptive capacity. In the context of the transition to a green and sustainable economy, knowledge related to environmental protection and efficient resource management is becoming increasingly important.

Educational projects carried out in schools and universities in Chișinău, as well as vocational training programs for adults, contribute to the development of human capital capable of responding to contemporary challenges. Also, skills such as critical thinking, solving complex problems and adaptability to emerging technologies are essential in creating a resilient city. A relevant example can be found in the various recycling and environmental protection initiatives, where citizens are encouraged to adopt sustainable practices through education and continuous training.

In recent years, the Republic of Moldova, including Chișinău, has gone through a severe energy crisis, marked by the sudden increase in energy and gas prices. This context has had a direct impact on the population, especially those with low incomes. During this period, skills and knowledge related to efficient resource management and energy saving became essential. Several local initiatives promoted education campaigns to encourage citizens to adopt more energy-efficient solutions, such as insulating homes or using more energy-efficient equipment.

In parallel, in many neighbourhoods of Chișinău, neighbourhood groups were formed and began to collaborate to identify common solutions to the energy crisis, such as purchasing collective energy-saving equipment or sharing the costs of more economical heating systems. These self-organization initiatives reflected the community's capacity to respond quickly and effectively to the energy crisis, using existing knowledge and resources.

Economic factors

The economic adaptation capacity of Chișinău Municipality is influenced by a series of essential economic factors, which include, among others, public financial resources, household income, level of education and vocational training, access to financial resources and insurance contracts. These indicators reflect the flexibility and resilience of the city's economy in the face of recent economic crises, market changes and financial challenges faced by the population.

Public financial resources

Public financial resources are essential for supporting the city's economic development and adapting to external challenges. In recent years, the budget of Chișinău Municipality has been consolidated, but also exposed to economic fluctuations, in particular due to the global energy and economic crisis.

According to data from the Ministry of Finance of the Republic of Moldova, in 2023, Chișinău recorded an increase in tax revenues of approximately 10%, which allowed the authorities to invest in infrastructure projects and public services. For example, funds were allocated for the modernization of transport networks and the improvement of the waste management system, two essential areas for the city to adapt to new challenges.

However, in the period 2022-2023, the increase in inflation and energy prices had a negative impact on the local administration's ability to maintain public spending at sustainable levels, which forced the authorities to seek external financing. Thus, Chișinău accessed funds from the European Union and other international donors to support climate change adaptation projects and urban infrastructure modernization.

Household income

Household income is a key indicator of a community's economic resilience. In Chișinău, the average household income has increased significantly in recent decades, but it still remains below the European Union average. According to a 2023 report by the National Bureau of Statistics, the average monthly household income in Chișinău was around 10,000 lei (around 500 euros), which places the city in a vulnerable position to economic crises, given that energy and essential goods prices have increased significantly.

In 2022 and 2023, rising utility and fuel prices significantly affected low-income households in Chișinău, widening economic inequalities. In this context, residents who depend on income from less stable sectors, such as trade or the IT sector, were more resilient. However, Chișinău benefits from a greater diversification of the local economy than other regions of the country, and the IT sector has been an important factor of stability, given that, in 2023, this sector generated approximately 12% of the municipality's GDP.

Education and Training Level

An important factor in Chișinău's economic resilience is the level of education and training of its population. A well-educated and adaptable workforce can respond more effectively to the demands of the global economy and contribute to sustainable economic development.

According to data from the Ministry of Education, Culture and Research of the Republic of Moldova, in 2023, the percentage of the adult population in Chișinău with higher education was approximately 25%, much higher than the national average of around 15%. This higher level of education in Chișinău facilitates the rapid adaptation of workers to changes in the labour market, especially in sectors such as IT, financial services and education.

In addition, in recent years, Chișinău has benefited from vocational training programs designed to help young people and adults develop the skills needed in a digitalized economy. Between 2021 and 2023, vocational training programs for unemployed youth were implemented, supported by international organizations such as the World Bank and the European Union. These initiatives contributed to reducing youth unemployment and improving the adaptability of the workforce to the demands of the modern economy.

Access to financial resources

Access to financial resources, such as credit and loans, is a key factor in Chișinău's economic resilience. According to the National Bank of Moldova, in 2023, interest rates on loans gradually decreased, allowing a significant part of the population to access loans for home purchases, renovations or business expansion. Small businesses in Chișinău also benefited from favourable lending programs to maintain their activity in the face of economic crises.

However, despite a general improvement in access to finance, recent economic crises, such as rising energy and commodity prices, have affected the ability of many households and SMEs to borrow. Data from 2023 show a decrease in credit demand among low- and middle-income households, which highlights the need for more effective economic policies to support them in times of crisis.

Insurance contracts

In an increasingly uncertain economic and environmental context, insurance contracts are becoming an important tool in protecting households and businesses against financial risks. In 2023, Chișinău recorded an increase in the number of insurance policies for homes and businesses, especially following the energy crisis and the floods in the summer of 2022, which affected the city's infrastructure.

According to data from the National Financial Supervisory Authority, in 2023, the insurance market in Chișinău recorded an increase of 6% compared to the previous year, which suggests an increased awareness of the importance of insurance in the face of economic and environmental risks. In this context, health and residential property insurance have become increasingly popular, and citizens are more willing to invest in these products to protect their income and assets in the face of economic and climate crises. Also, small businesses in Chișinău were encouraged to take out insurance policies to protect their activities against economic risks, which can contribute to maintaining a more stable economy.

Technological factors and scientific knowledge

The adaptive capacity of Chișinău Municipality in the face of economic, social and environmental challenges can also be assessed through the lens of technological factors and scientific knowledge. The availability of technological, social, institutional and environmental innovations, as well as the ability to use these innovations, are fundamental elements that influence the degree of adaptability of the city to global changes. Also, access to information on adaptation to climate change and other major risks is another essential indicator of Chișinău's adaptive capacity.

Availability of technological, social, institutional, environmental and other innovations

Technological innovations are essential for modern urban development and for increasing the capacity to adapt to climate change and other crises. Chișinău, as a major urban centre in the Republic of Moldova, has gradually started to adopt innovative technologies, especially in the fields of transport, renewable energy and the digitalization of public services.

Over the past 5 years, Chișinău has implemented various technological solutions to improve the quality of urban life and support the transition to a more sustainable city. For example, the municipal authorities have invested in expanding the electric public transport network, including electric buses and trolleybuses, thus contributing to reducing CO2 emissions and improving air quality. According to 2023 data from the Chișinău Transport Directorate, approximately 20% of the city’s public transport fleet is now electric, and this percentage is growing.

In addition, Chișinău has begun to adopt smart city solutions, including the implementation of sensors for monitoring traffic and air quality, which allows for more efficient city management and a rapid response to changes that may affect the urban environment. These institutional and technological innovations represent an important step in increasing the city's adaptive capacity to climate and economic challenges, and their integration into the city's development plans will play a crucial role in the future.

Ability to use the innovations

Chișinău’s ability to use technological innovations is another key factor in assessing its adaptive capacity. Although there is significant progress, the implementation of new technologies depends

largely on the availability of financial resources, but also on the education and continuous training of the workforce, so that it can adopt and use modern technologies effectively.

A concrete example of the use of technological innovations is the digitalization of public services in Chișinău. Starting in 2021, Chișinău City Hall launched online platforms for accessing various public services, including paying taxes and fees, obtaining permits and licenses, as well as requesting information for various infrastructure projects. This type of social and institutional innovation facilitates citizens' access to services, increases the transparency of public administration, and reduces bureaucracy.

In parallel, the city has begun to invest in the digital education of citizens and public employees. Digital training initiatives, supported by local authorities in collaboration with various international organizations, have allowed many citizens and public servants to learn how to use digital tools, making the city more adaptable and prepared for economic and social challenges.

Availability of information on adaptation to climate change

Another important indicator of Chișinău's capacity to adapt to climate change is the availability of information and scientific research on the impact of these changes on the city. Information is essential for formulating effective public policies and for educating citizens about the risks and necessary protective measures.

Chișinău benefits from several initiatives aimed at raising awareness and adapting to climate change. A concrete example is the "Action Plan for Sustainable Energy and Climate Change", launched in 2020, which includes measures to reduce greenhouse gas emissions, improve energy efficiency and promote renewable energy. This plan was developed with the support of the European Union and other international partners and includes a series of concrete measures for the city's adaptation to climate risks.

Chișinău has also been included in international climate change monitoring programs, such as the "Paris Agreement" and the "Green City" initiatives, which provide up-to-date data and research on the impact of climate change on the region. This information is used to plan protection and adaptation measures, such as investments in green infrastructure, stormwater management solutions and improving the energy efficiency of public buildings.

In addition, there is increasing collaboration between municipal authorities and non-governmental organizations to raise awareness and educate the general public about climate change. Education and information projects, such as tree planting campaigns or promoting recycling, have become increasingly common, thus contributing to the integration of ecological and sustainability factors into the daily lives of Chișinău residents.

5. Conclusions

The analysis of the Urban Heat Island phenomenon in Chișinău highlighted a significant correlation between urbanization, building density and increasing local temperatures. This correlation suggests that as the city develops and expands, the negative effects on the urban environment become increasingly pronounced. Central areas and those with low vegetation cover were identified as being the most affected by this phenomenon, which underlines the urgent need to address these issues through sustainable urban development policies.

The assessment process demonstrated the importance of involving stakeholders at all stages. Such involvement not only improves the quality of decisions, but also increases the acceptability of proposed solutions among the community. Consultations and workshops facilitated open communication and ensured that community perspectives were integrated into the formulation of solutions, thus contributing to creating a sense of ownership and shared responsibility towards the environment.

Based on the analysis obtained, it is recommended to implement three basic strategies, as follows:
1. Creating and maintaining parks and green spaces. These areas not only help reduce temperatures, but also provide recreational places for citizens, improving the quality of life.
2. Promoting green roofs and sustainable drainage systems. These innovative solutions can help manage stormwater and reduce the heat island effect, while having a positive aesthetic impact on the city.
3. Improving urban planning to include more green areas. Careful urban planning can transform the city into a more nature-friendly environment, contributing to a healthy urban ecosystem.
Public education and community awareness are essential to support environmental initiatives. Informing citizens about the effects of UHI and how they can contribute to solving this problem is crucial. Information campaigns can help mobilize the community and promote environmentally friendly behaviours, thus creating a culture of environmental responsibility.

At the same time, continuing research on the Urban Heat Island phenomenon is crucial to monitor the effects of implementing mitigation solutions. This research can provide valuable data to support future decisions and ensure rapid adaptation to climate change. A periodic assessment of temperatures and the impact of adopted measures is necessary to adjust strategies based on results and maximize their efficiency.

In conclusion, the Urban Heat Island phenomenon represents a significant challenge for Chișinău, but through a collaborative approach and the implementation of sustainable solutions, the city can become more resilient to the effects of climate change. This transformation requires a joint commitment from the authorities, the community and experts, ensuring a healthier and more pleasant urban environment for all residents. Only through concerted and well-coordinated action can sustainable results be achieved in combating UHI and improving the quality of life in the city.

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