

# THE 2021-2030 INTEGRATED URBAN DEVELOPMENT STRATEGY OF THE CRAIOVA URBAN AREA

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## ENVIRONMENT AND CLIMATE CHANGE

The environmental issues are increasingly gaining in importance at global, European, national and local level. At global level, the United Nations has developed the Sustainable Development Framework, with a set of targets to be achieved by 2030. Romania has developed its own Sustainable Development Strategy 2030, and Goal 11 - "Sustainable Cities and Communities" - focuses on decent housing, seismic risk, risk of flooding and landslides, air quality, the cultural dimension of sustainable development and smart cities. The environmental targets set for the 2030 horizon include:

- Significantly reduce the economic losses caused by flooding and landslides, improve the collective response and strengthen the capacity to adapt and return to a functional situation in the shortest time possible after occurrence of the event, reduce the impact of flooding or the pollution caused by flooding and landslides on the ecosystem, including by means of constant improvements to the legislative framework.
- Educate and empower the population in respect of earthquake risk situations.
- Reduce the impact the atmospheric pollution has on human health and the environment through a special focus on air quality.
- Substantially reduce the number of deaths and diseases caused by dangerous chemical products, pollution and the contamination of the air, water and soil.

At EU level, the 2021-2027 programming period is organized under the "Green Deal" umbrella framework, with substantial resources allocated for a greener Europe. Each member state shall allocate 30 % of the European Regional Development Fund resources at national level (approx. EUR 5.2 billion in the case of Romania) for investments in green infrastructure. An amount of minimum EUR 88 million is currently allocated for Craiova under the Regional Operational Program South-West Oltenia Region, with a special focus on sustainable mobility and urban regeneration.

The Integrated Urban Development Strategy of the Craiova Growth Pole, developed in 2017 for the 2014-2020 programming period, includes a comprehensive analysis of the environmental issues. Parts of this analysis will be summarized in this chapter, but the main focus will be on providing additional data and information so as to have a more comprehensive understanding of the environmental dimension for Craiova - for the city, the metropolitan area and the functional urban area.

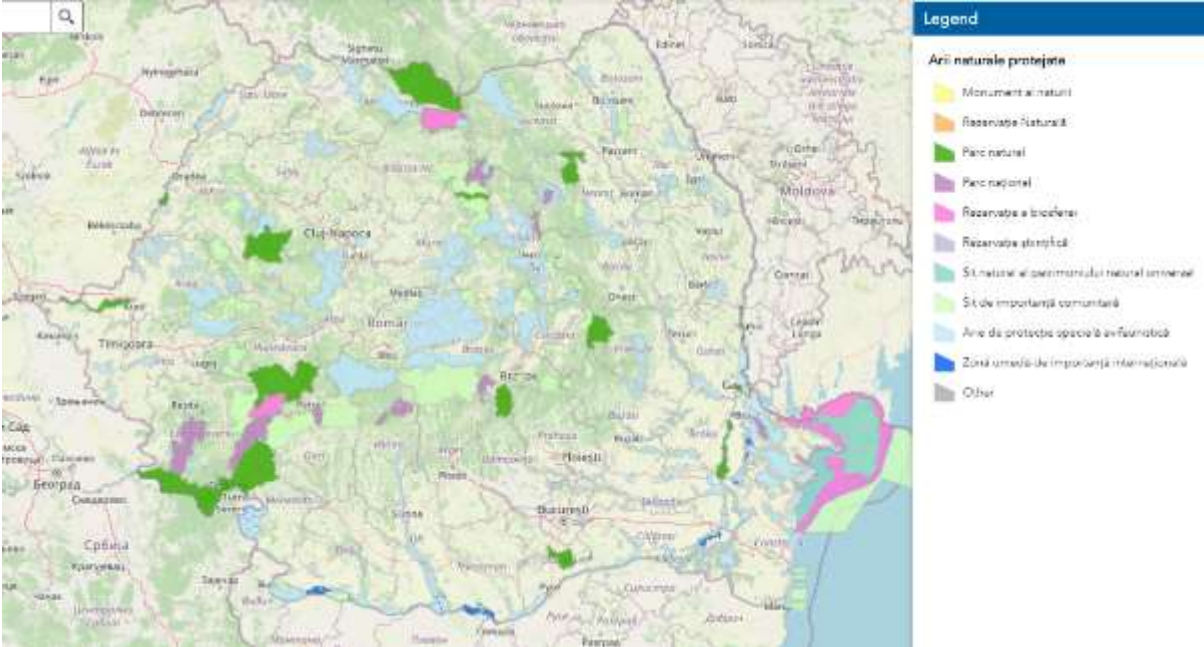
The Craiova IUDS 2024 includes climate details related to solar radiation, wind, snow cover, atmospheric precipitation and topoclimate characteristics. In addition to these data, this chapter will provide a broader analysis of how climate, and especially climate change, can affect Craiova's development prospects.

The fight against climate change is one of the most important priorities worldwide and most countries in the world got involved in this fight. It is the utmost priority for the European Union in the coming years and considerable resources have been made available to Member States for climate change mitigation and adaptation. This is also one of Romania's main priorities, according to the National Sustainable Development Strategy 2030, the Urban Policy 2035 or the programming documents for attracting EU funds in the 2021-2027 programming period.

# NATURE RESERVES AND PROTECTED AREAS

## Protected natural areas

Figure 1. Protected natural areas in Romania



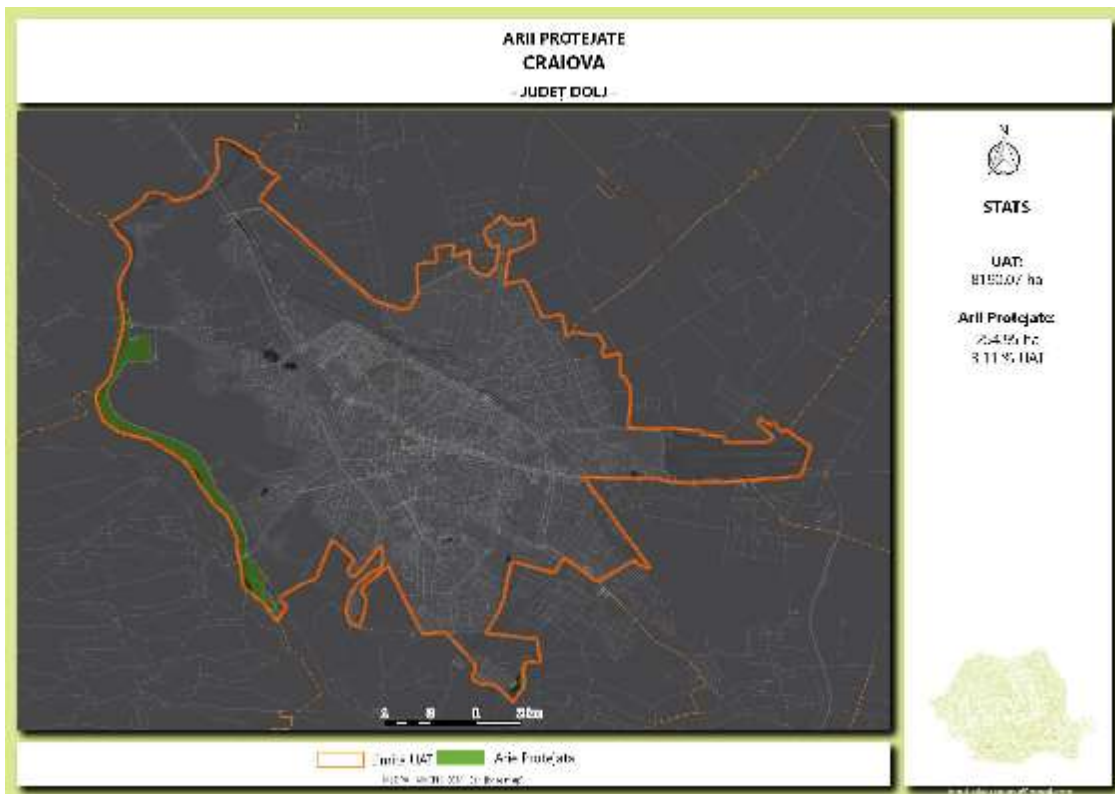
Source: Transport Master Plan

Figure 2. Protected natural areas in Dolj county



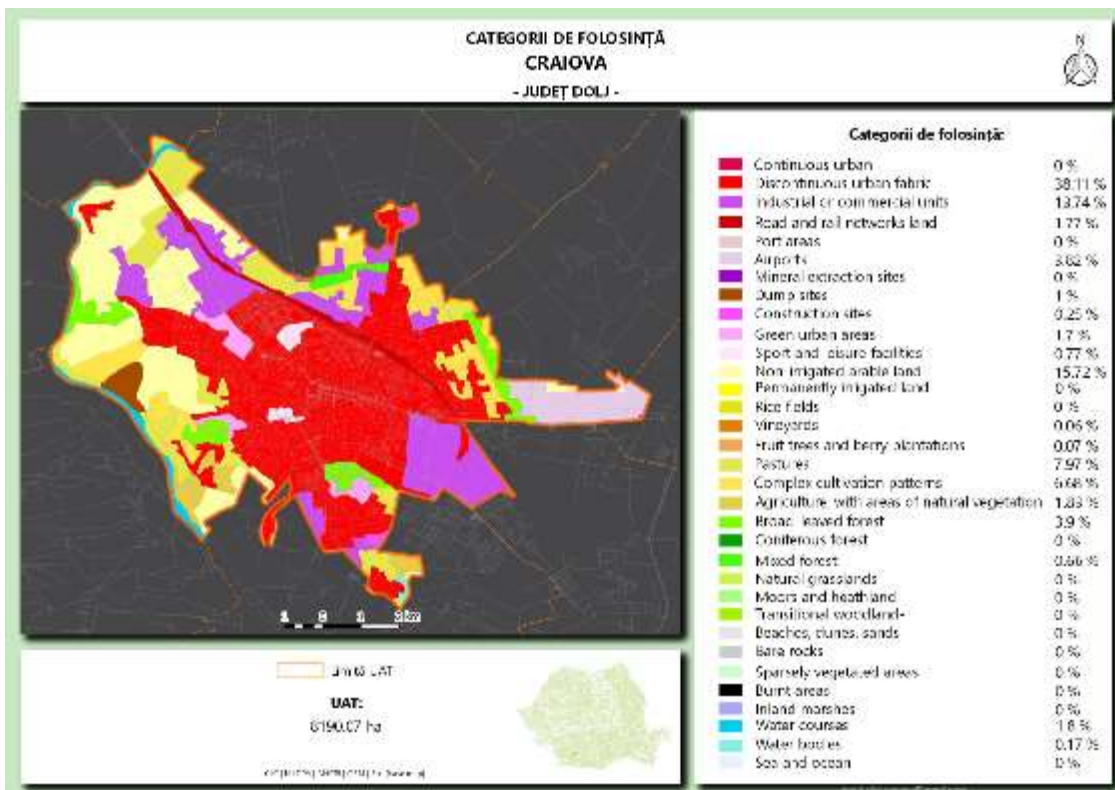
Source: Transport Master Plan

Figure 3. Protected natural areas in Craiova



Source: Romania's Urban Policy

Figure 4. Use categories for Craiova



Source: Romania's Urban Policy

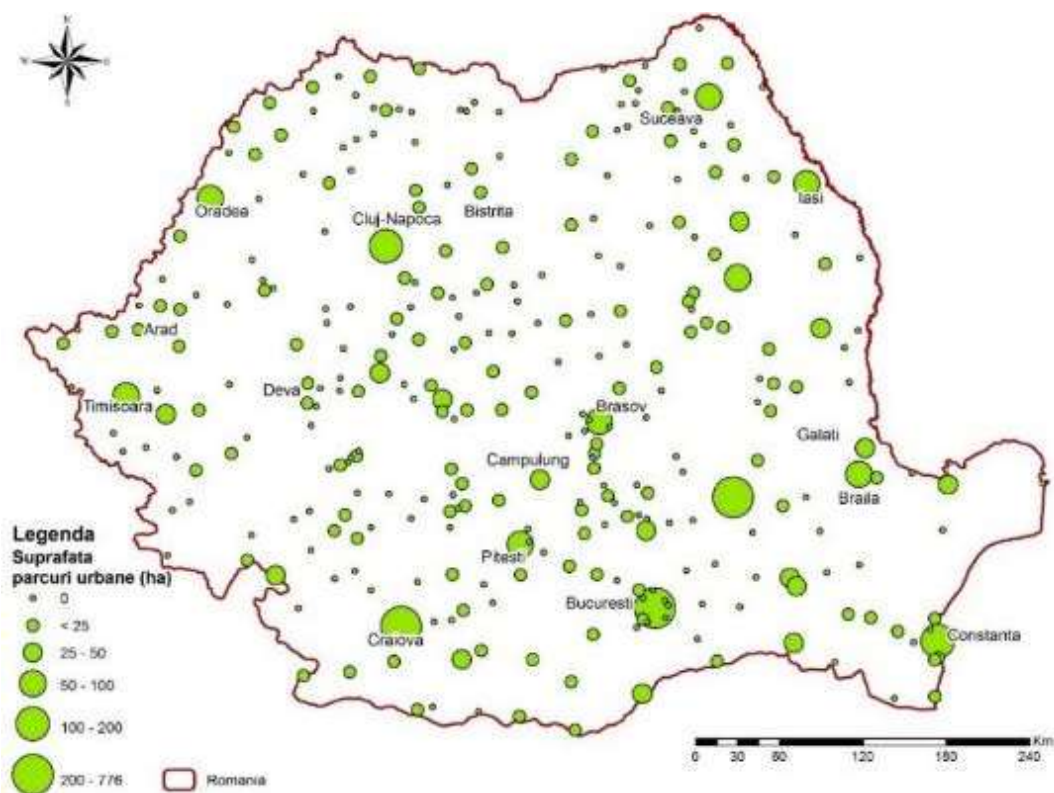
## Urban green areas

Increasing the green areas and facilitating access to these areas is one of the most efficient ways to increase the quality of life in a city. In his book, "Happy City", Charles Montgomery talks about the importance of green areas not only for improving our quality of life, but also our health. In addition to the obvious recreational and environmental benefits (reduction of air pollution, of the heat island effect, keeping the water flows under control), the green areas also have a well-documented psychological benefit. One of the famous studies mentioned in "Happy City" was conducted in a hospital in the United States and analyzed patients split in two groups - one group overlooking a green area in front of the hospital and the other group overlooking the wall of another building. The study was aimed at identifying the potential effect of "access" to green areas on the psychological well-being of patients and on their recovery rate. The study results clearly showed not only a faster recovery rate for the patients overlooking the green area, but also a much lower incidence of death than in the case of the group overlooking a building wall.

Therefore, the development, rehabilitation and maintenance of the urban green infrastructure should be an absolute priority for every municipality in the country. Unfortunately, Romania has a poorly developed green infrastructure. Only 5 of the county seats in Romania have more than 26 m<sup>2</sup> of publicly accessible green area per inhabitant, which is the amount recommended by the European Commission for urban areas. Craiova is one of these 5 county seats, with 34 m<sup>2</sup> of green area per inhabitant, which means it has a solid foundation to build upon.

The urban parks are particularly important due to their larger areas, their complex facilities and their level of ecological and social multifunctionality. They are providing the population with a wide range of important cultural services, such as recreation, practicing of sports activities, socializing and outdoor experience. The map below shows the absolute areas of the urban parks in Romania. Craiova ranks 3rd at national level, behind Bucharest and Buzău.

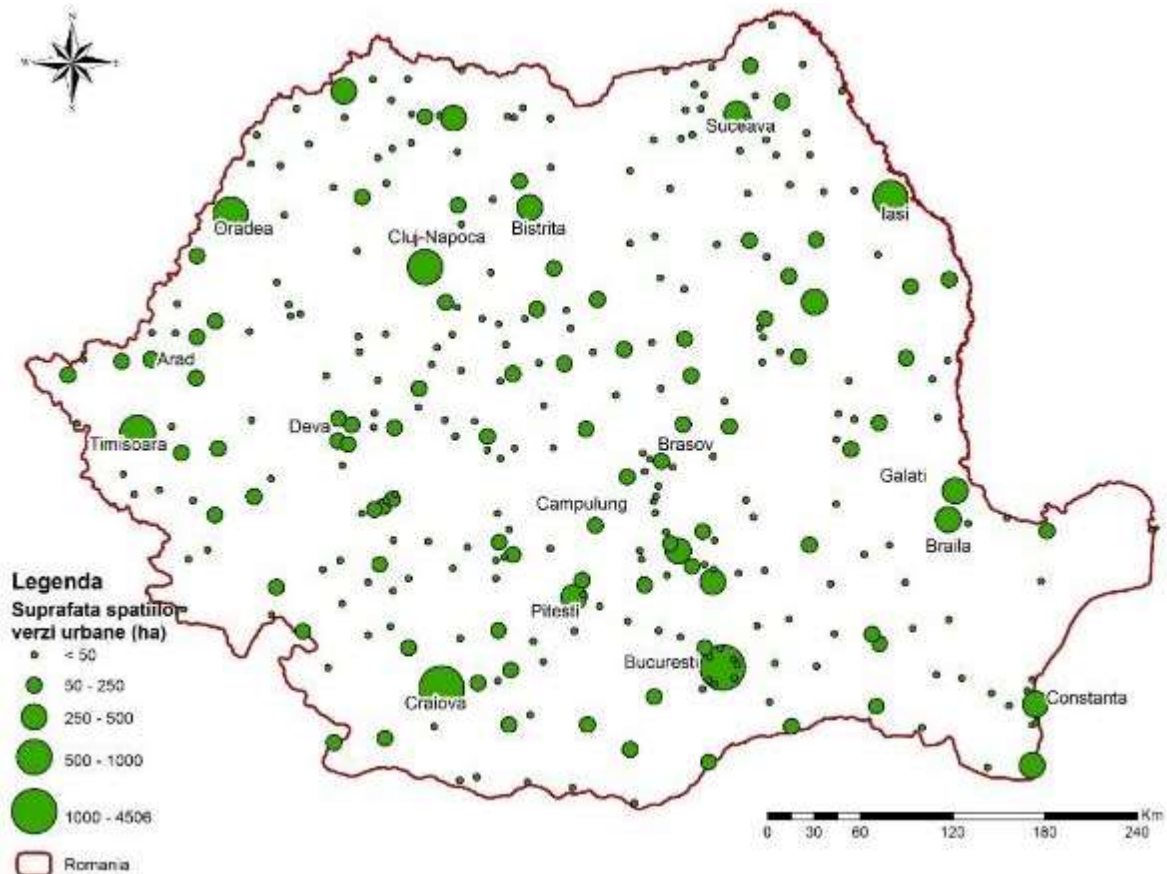
**Figure 5. Urban park area, at national level**



**Source: Romania's Urban Policy**

Another important indicator is the urban green area, which includes parks, public gardens or public squares, cemeteries and sports facilities within the localities' developable areas. These green areas are a balancing element for the urban grey infrastructure. The map below shows the distribution of the urban green areas at national level. Craiova ranks 2nd at national level from this perspective, after Bucharest.

**Figure 6. Urban green areas, at national level**

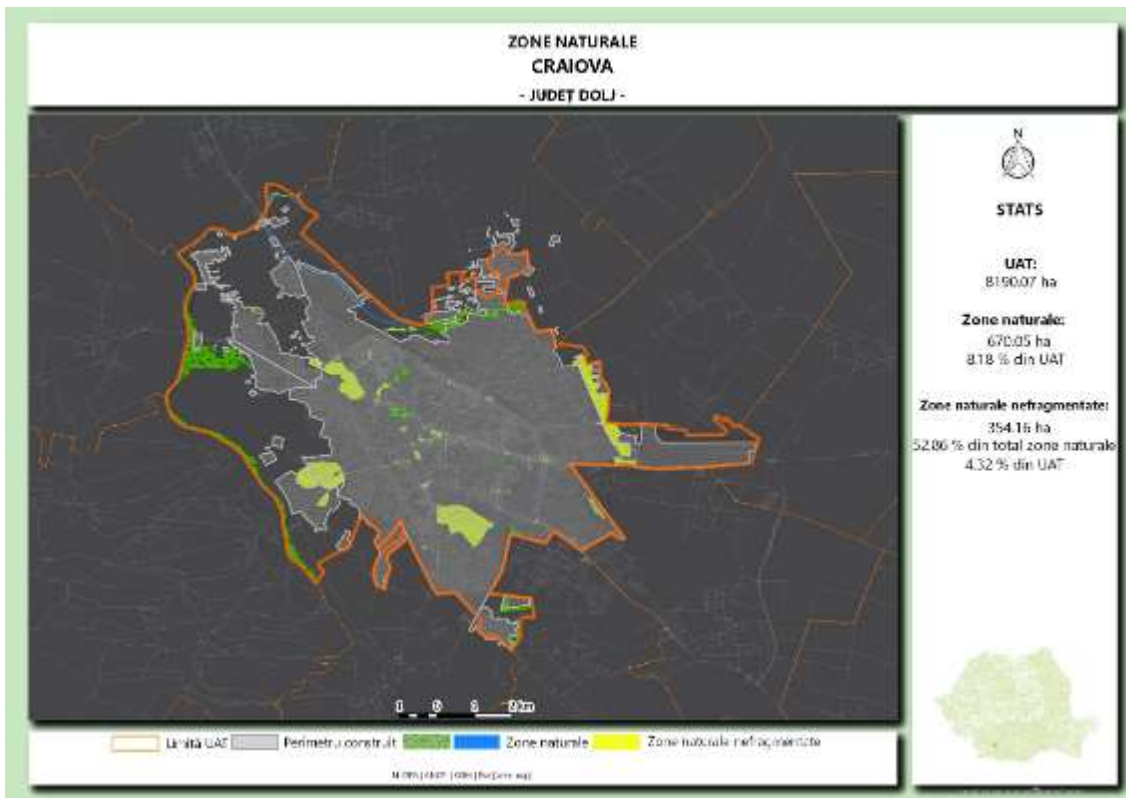


**Source: Romania's Urban Policy**

The pictures below are mapping the green areas in Craiova and the degree of accessibility of these green areas. The green areas are quite diverse - from large parks (such as the famous Romanescu Park or Craiovița Park) to small green squares, from leisure and relaxation areas (e.g. Tineretului Park) to areas for exploration and contemplation (e.g. the "Alexandru Buia" Botanical Garden). The most important green areas and parks in Craiova according to the Craiova IUDS 2024 are: 1. Romanescu Park; 2. Tineretului Park (former Lunca Jiului Park); 3. Sf. Dumitru Park (Grădina Băniei); 4. Grădina Unirii (English Park); 5. National Theater Park; 6. Botanical Garden; 7. Crizantemelor Park; 8. Grădina Trandafirilor or Grădina Frații Buzești; 9. Grădina Mihai Bravu; 10. 1 Mai Park; 11. Hanul Doctorului Park; 12. Craiovița Park; 13. Cornițoiu Park.

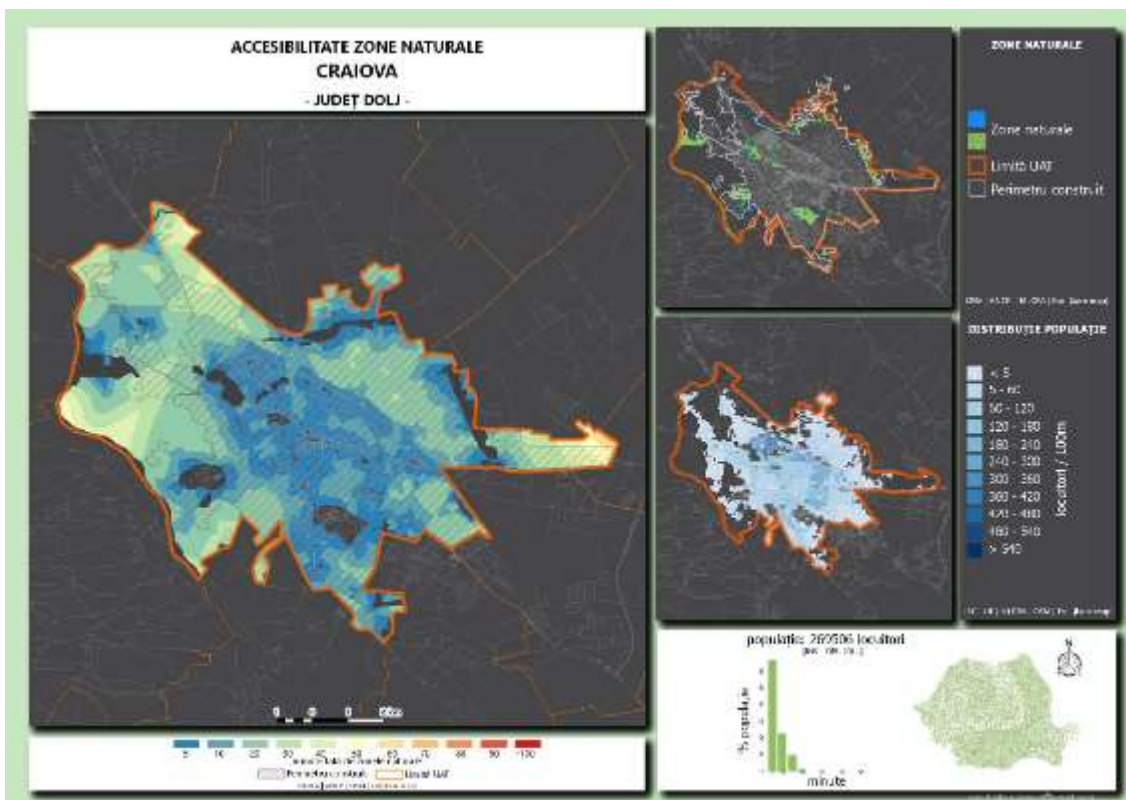
These green areas are also quite easily accessible. Thus, approx. 67 % of the inhabitants of Craiova are living less than 5 minutes, 23 % are 10 minutes and 9 % are 20 minutes away from a green area. There is still room for improvement in this area. For example, 91 % of the inhabitants of Târgu-Mureș, 85 % of the inhabitants of Cluj and Iași, 78 % of the inhabitants of Timișoara, or 74 % of the inhabitants of Satu Mare, Sibiu or Brașov are living 5 minutes away from a green area. In addition to expanding the classic green area infrastructure (parks, squares), one measure that could improve the quality of life in the city is the implementation of a "no street without greenery" program, through which green infrastructure can be introduced in every corner of the city.

Figure 7. Green areas in Craiova



Source: Romania's Urban Policy

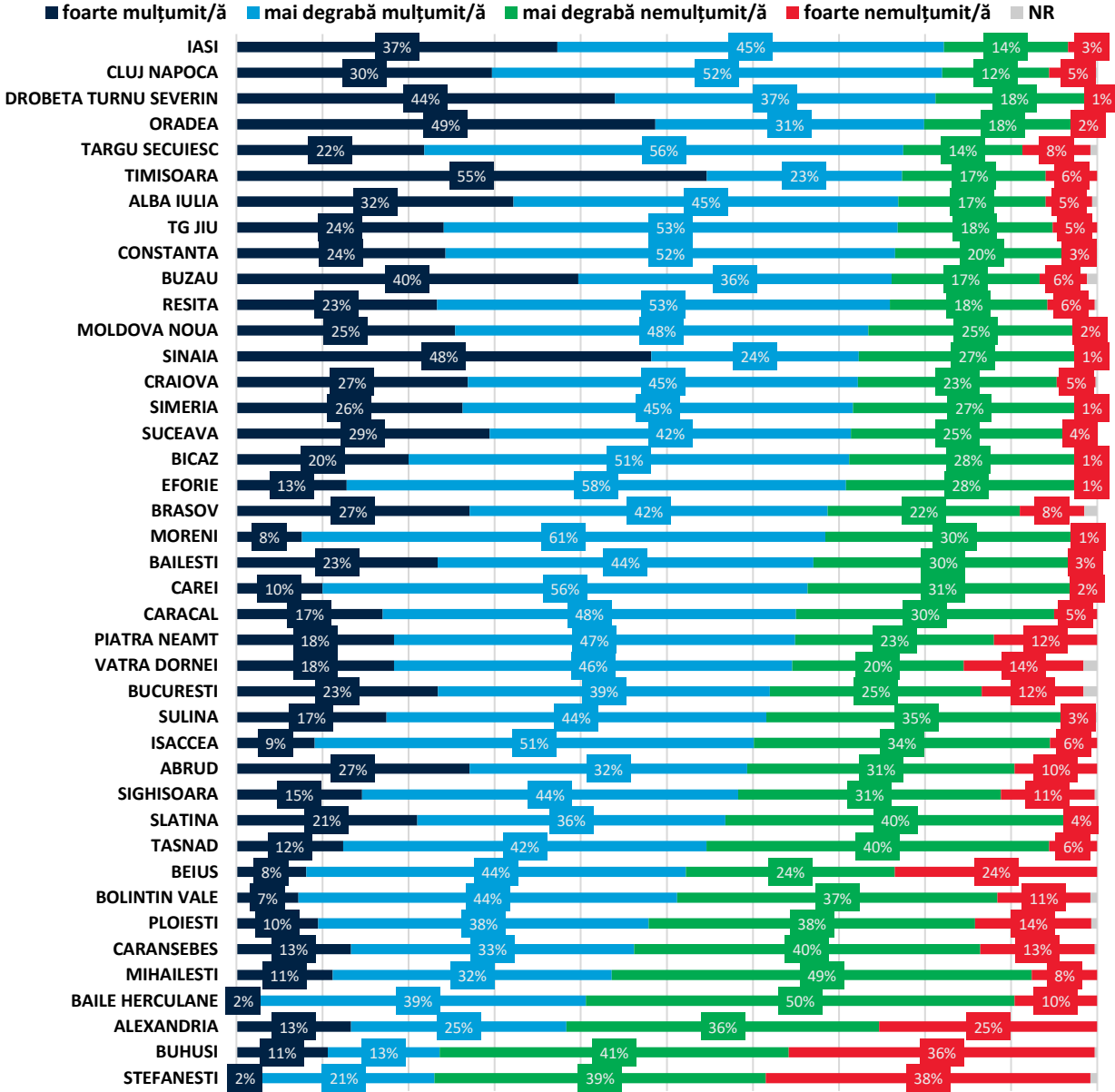
Figure 8. Accessibility of green areas in Craiova



Source: Romania's Urban Policy

The inhabitants of Craiova are generally satisfied with the available green areas in the city. The 2020 Urban Barometer, conducted for the development of the Romania’s Urban Policy, assessed the degree of satisfaction with green infrastructure in 41 cities and towns in Romania. Craiova is among the cities with the highest degree of satisfaction from this perspective, 27 % of the respondents stating that they are very satisfied and 45 % satisfied. The cities and towns with a higher degree of satisfaction with green areas were generally those that provided better access for the population to these green areas – even in those with a smaller absolute green area or with a smaller green area per inhabitant.

**Figure 9. Urban Barometer. Answer to the question: How satisfied are you with the green areas in your city?**



Source: Romania’s Urban Policy

At the level of the Functional Urban Area (FUA), the town of Filiși has approx. 33 m2 of green area per inhabitant, while the town of Segarcea approx. 25 m2 per inhabitant. The rehabilitation, modernization and development of the green infrastructure in all the localities in the FUA will obviously be of interest and the development of a metropolitan green belt can also be considered. According to the Craiova IUDS 2024, the Craiova functional urban area has over 22,000 ha of forests and forest vegetation - a strategic natural resource that can help increase the quality of life in the area.

## THE QUALITY OF ENVIRONMENTAL FACTORS AND URBAN POLLUTION (WATER, AIR, SOIL)

Pollution is an increasingly important issue in Romania and of vital importance for the Romanian cities and towns. Two sectoral strategies have been developed for Craiova to address this issue - the Craiova City Air Quality Plan for 2020-2024 and the Craiova Green City Action Plan. As part of the 2020 Urban Barometer, conducted for the development of the Romania's Urban Policy, the inhabitants of the Romanian cities and towns were asked to list the most important interventions for their communities. The first three urban priorities identified are: 1) healthcare services (39 % of the respondents); 2) air pollution (32 %); and 3) road infrastructure (29 %). Therefore, local governments in Romania cannot ignore this issue in the coming years.

The figure below shows the main sources of pollution and monitoring stations at the level of Craiova TAU. It can thus be seen that the main sources of pollution in Craiova are the manufacturing and transport activities.

**Figure 10. The main sources of pollution and monitoring stations, Craiova TAU**



Given the importance of urban pollution, we will include a more detailed analysis on this dimension in the following pages and we will try to see what the main sources of pollution in Craiova are. It should be mentioned from the very beginning that the environment quality monitoring system in Romania is deficient. For example, the air pollution monitoring stations are insufficient, often poorly located (industrial activities have moved outside the cities) and in some cases non-functional. Other limitations of the environment quality monitoring system include: the small number of indicators that can be monitored at an appropriate frequency; the difficulty of maintaining a unitary assessment methodology at national level; low flexibility regarding the network extension, when needed. The situation is even more complicated at urban level, given the much greater diversity of factors influencing the dynamics of environment quality indicators and the much higher level of population exposure.

The main conclusions of the Romania's Urban Policy on the quality of the environment in the Romanian cities and towns include:

- As a general trend, the quality of the environment in the Romanian cities and towns is deteriorating due to the increasing intensity and magnitude of some stationary and diffuse sources (industrial units, road traffic, residential areas with poor connection to public services), the decreasing quality of public services (sanitation of public areas, including green and aquatic areas) and the reduction of construction-free areas inside and outside the cities and towns;
- Road traffic is one of the main sources of environmental degradation in the Romanian cities and towns;
- The expansion of the localities' territory, including through urban sprawl, creates significant waste and wastewater management, as well as hygiene problems;
- The increasing impermeable surfaces, especially due to the expansion of residential buildings, commercial platforms and communication channels, are causing more and more water management problems in the cities and towns;
- The poor air quality in some areas stems from both the regional changes (smaller areas covered by forests, which exacerbate the wind erosion issues, increased intensity of some air pollution sources outside the city/town), as well as the changes in the cities and towns (significant increase in the number of vehicles congesting the road traffic, expansion of buildings, activation of the small and medium-sized economic agents);
- The significant water quality issues of some river sectors, especially downstream of cities and towns, caused by the insufficient wastewater treatment are linked to the expansion of built areas that are not connected to the sewer system;
- The waste management problems are exacerbated by the increase in the amount and the diversity of waste, the low recycling rate and the use of land filling as the main disposal method;
- The constant problems related to contaminated sites, due to the lack of investment in their ecological restoration, is a challenge faced by post-industrial cities and towns;
- Invasive and opportunistic species tend to become an increasingly costly problem for the Romanian cities and towns, with increasingly serious social and economic implications.

### **Water bodies quality and pollution**

Different morphometric, physical, chemical, biological and microbiological indicators are used to analyze the ecological status of water bodies. The National Administration Romanian Waters is responsible for determining the ecological status of water bodies, which is used to assess their potential to support the aquatic ecosystems, but also to provide high quality water resources needed for different water uses.

The World Bank has developed, on behalf of the Ministry of Regional Development and Public Administration, an "Investment Guide for Water and Wastewater Infrastructure", which also mapped the quality of all the water bodies in Romania, based on the data provided by Romanian Waters. According to these data, the Jiu river has a moderate, poor or bad water quality all along Dolj county. However, many rivers that drain into Jiu have a good or very good water quality. These rivers can contribute to the development of the blue-green infrastructure.

**Figure 11. The ecological potential of water bodies in the Craiova urban area**



**Source: Investment Guide for Water and Wastewater Projects, World Bank, 2015, available at <http://old.mlpda.ro/userfiles/smis48659/ghid3.pdf>**

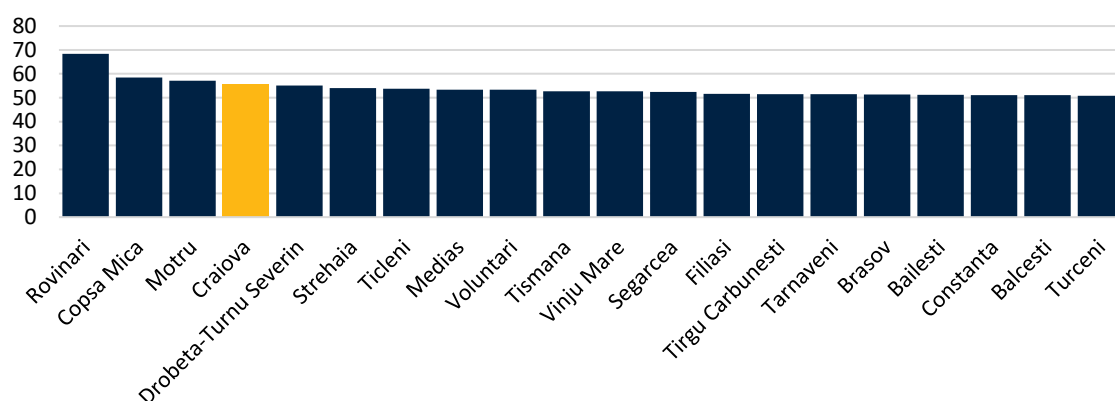
A factor that can affect the water quality at urban level is the share of impermeable surfaces in a city/town, i.e. surfaces that do not allow water to infiltrate into the soil. A low soil permeability can have a negative impact on the regulating ecosystem services. According to the 2018 data provided by the National Institute of Statistics, Craiova ranked 9th at national level in terms of urban impermeable surface. The reduction of the impermeable surfaces can have a positive impact not only on the quality of urban soil and water bodies, but it can also help diminish the urban heat island effect, which is particularly keenly felt in Craiova.

### **Air quality and pollution**

The air pollution has the most direct and acute impact on the quality of life in cities/towns. There are multiple sources of air pollution, with different impact on people's health. The air pollution is generally the result of anthropogenic activities (e.g. industrial activities, motorized transport, heating, electricity generation, etc.), with both a local impact and over a wider area. In the following pages, we will discuss some of the main sources of air pollution and how they affect the Craiova urban area.

According to an analysis assessing the air quality in all the cities and towns in Romania, carried out by a team led by Cristi Ioja from the University of Bucharest, Craiova ranks 4th in the country in terms of pollution. The inhabitants of Craiova are among the most dissatisfied people with the air quality in their city.

**Figure 12. The specific air quality index in the Romanian cities and towns, 2015**



**Source: Romania’s Urban Policy**

It should be mentioned that there are 5 air monitoring stations in Craiova, as detailed in the table below: Given the rather high level of pollution in Craiova, it might be worth considering expanding and upgrading the air quality monitoring stations in the area.

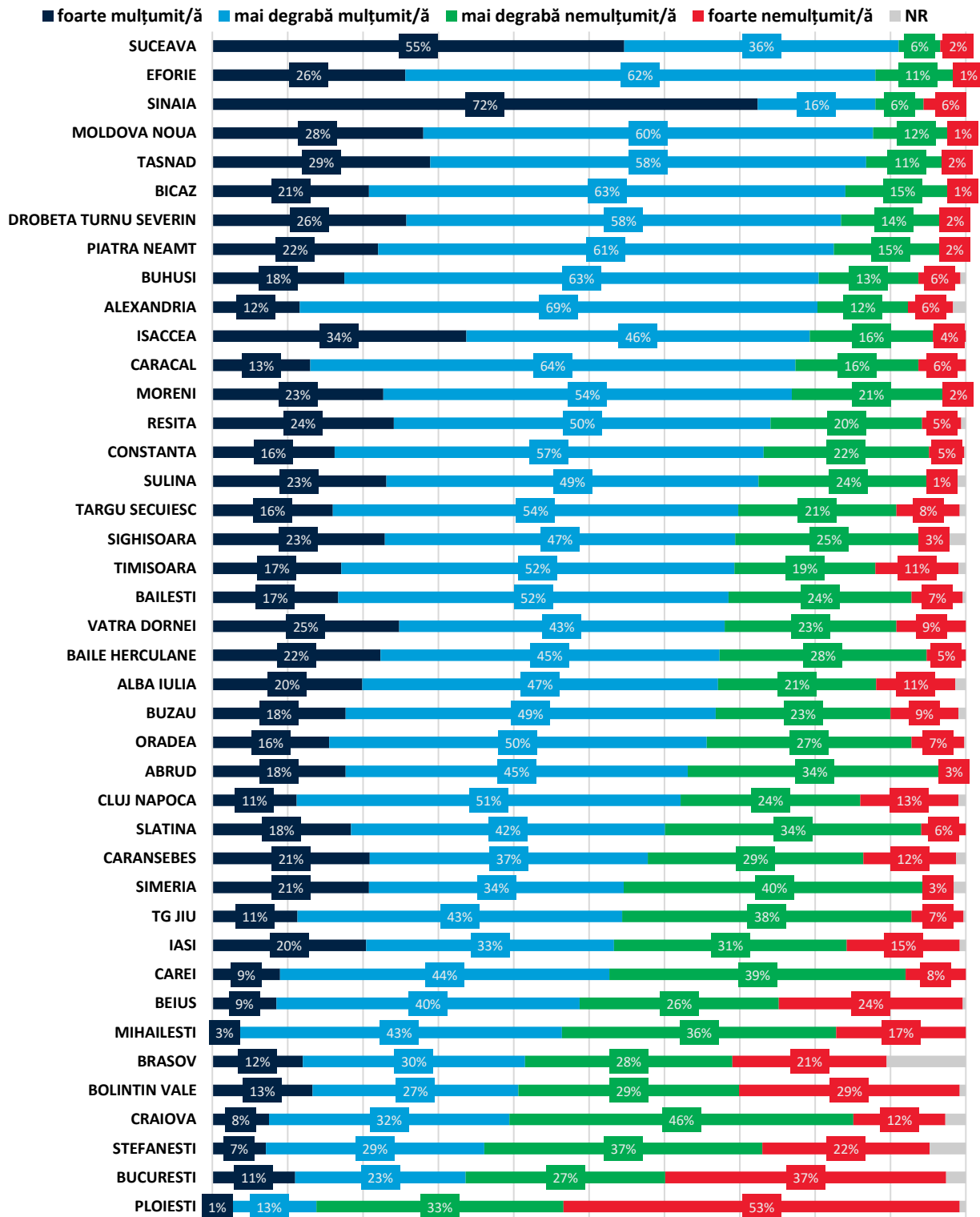
**Figure 13. Air monitoring stations in Craiova**

No.	Station name	Station type	Station address	Monitored pollutants
1	DJ-1 Calea București	traffic station	Calea București	Benzene, CO, Ethylbenzene, m-Xylene, NO, NO <sub>2</sub> , NO <sub>x</sub> , o-Xylene, p-Xylene, PM <sub>10</sub> , SO <sub>2</sub> , Toluene
2	DJ-2 City Hall	urban background station	A. I. Cuza	Benzene, CO, Ethylbenzene, m-Xylene, NO, NO <sub>2</sub> , NO <sub>x</sub> , o-Xylene, p-Xylene, PM <sub>10</sub> , SO <sub>2</sub> , Toluene, Wind direction, Amount of precipitation, Air pressure, Solar radiation, Relative humidity, Wind velocity, Air temperature
3	DJ-3 Billa	industrial and traffic station	Maria Tănase	NH <sub>3</sub> , NO, NO <sub>2</sub> , NO <sub>x</sub> , Nt, O <sub>3</sub> , PM <sub>10</sub> , SO <sub>2</sub>
4	DJ-4 Ișalnița	industrial station	Entry to Ișalnița Sud	NO, NO <sub>2</sub> , NO <sub>x</sub> , O <sub>3</sub> , SO <sub>2</sub> , Wind direction, Amount of precipitation, Air pressure, Solar radiation, Relative humidity, Wind velocity, Air temperature
5	DJ-5 Breasta	suburban background station	Breasta Water Station	CO, NO, NO <sub>2</sub> , NO <sub>x</sub> , O <sub>3</sub> , PM <sub>10</sub> , SO <sub>2</sub> .

**Source: The Craiova City Air Quality Plan for 2020-2024**

These technical data were corroborated by a sociological survey. The 2020 Urban Barometer, conducted for the development of the Romania’s Urban Policy, assessed the degree of satisfaction with air quality in 41 cities and towns in Romania and found that 58 % of the respondents wanted to feel an improvement in this area.

Figure 14. Urban Barometer. Answer to the question: How satisfied are you with the air quality in your city?



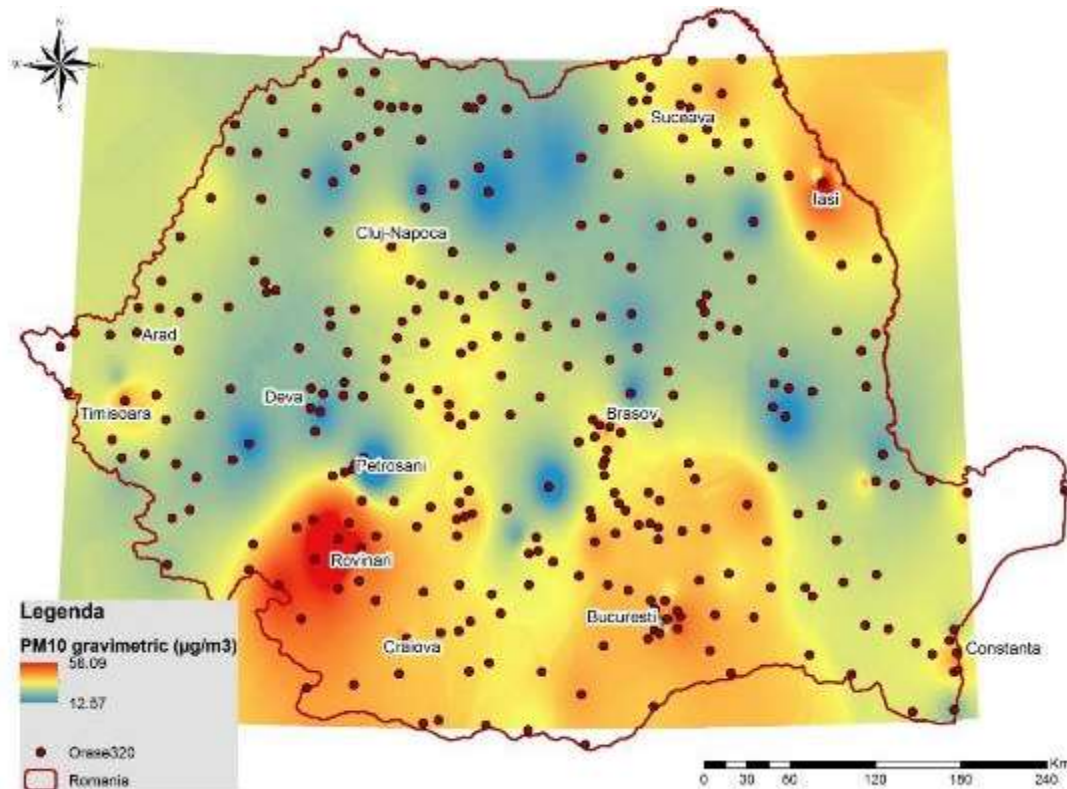
Source: Romania's Urban Policy

A number of environmental quality indicators, which were determined following an analysis carried out for the development of the Romania's Urban Policy, are discussed below.

### *The concentration of airborne particulate matter (PM10)*

These data are reported on the [calitateair.ro](http://calitateair.ro) platform and refer to the concentration of airborne particulate matter that are less than 10 micrometers in diameter, either from natural sources (natural background made up of erosion rocks deposits) or anthropogenic sources (industrial, transport, construction emissions). The particulate matter can have adverse effects on the human health and may be responsible for a number of respiratory problems. The map below shows the regions with a higher concentration of this pollutant.

**Figure 15. Concentration of particulate matter (PM10) at national level, 2015**



**Source: Romania's Urban Policy**

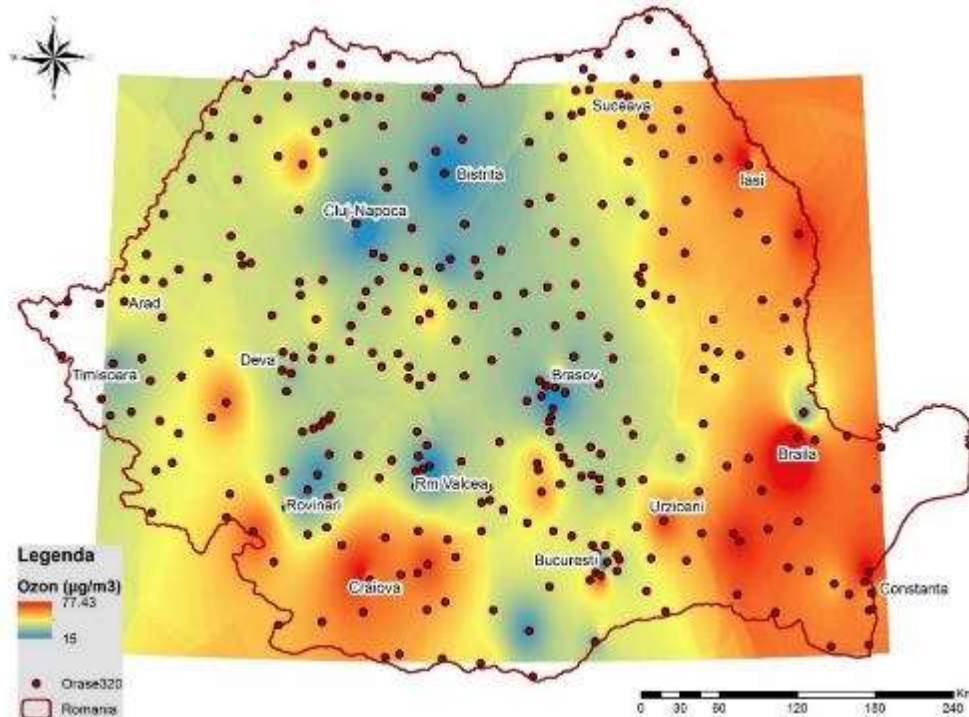
The cities/towns located in the plain and plateau areas are the most affected by this type of air pollution, due to the air masses that spread such particulate matter. The only area where the annual limit values were exceeded is the Motru-Rovinari coal basin, at the edge of which Craiova is located. High values, close to the permissible limit value, are recorded in the Romanian Plain, the Moldavian Plain, in the Braşov Depression and in some urban areas of regional importance (Bucharest, Iaşi, Constanţa, Timișoara, Cluj-Napoca, Braşov). Craiova is somewhere in the middle of the national ranking regarding the concentration of particulate matter, so this is not a significant source of pollution. Complexul Energetic Oltenia, which is the main source of particulate matter pollution, has implemented in recent years dense slurry systems for the evacuation of slag and ash resulted from the coal combustion. Further similar investments are planned in the coming years.

The average concentration of particulate matter in Craiova was approx.  $30 \mu\text{g}/\text{m}^3$  in 2015. On October 3, 2020, when this chapter was prepared, one of the air monitoring stations in Craiova recorded a concentration of  $43 \mu\text{g}/\text{m}^3$ . Another air monitoring stations in the city recorded a concentration of  $0.33 \mu\text{g}/\text{m}^3$ . The annual limit value to be observed starting with January 1, 2020, is  $20 \mu\text{g}/\text{m}^3$ . The annual limit value for the protection of human health is  $40 \mu\text{g}/\text{m}^3$  and the daily limit value is  $50 \mu\text{g}/\text{m}^3$ .

### *The concentration of tropospheric ozone (O<sub>3</sub>)*

The tropospheric ozone is an indicator of photochemical smog and is particularly problematic during the summer months. This pollutant is a strong oxidant, which can have adverse effects on human health and the ecosystems. High concentrations of ground-level ozone can affect the respiratory system of humans and animals, as well as the process of photosynthesis for plants, thus reducing their resistance to diseases. A higher concentration of tropospheric ozone is recorded in the cities and towns located in the Romanian Plain, the Dobrogea Plateau and the Moldavian Plateau, where the solar radiation is also higher.

**Figure 16. Concentration of tropospheric ozone (O<sub>3</sub>) at national level, 2015**



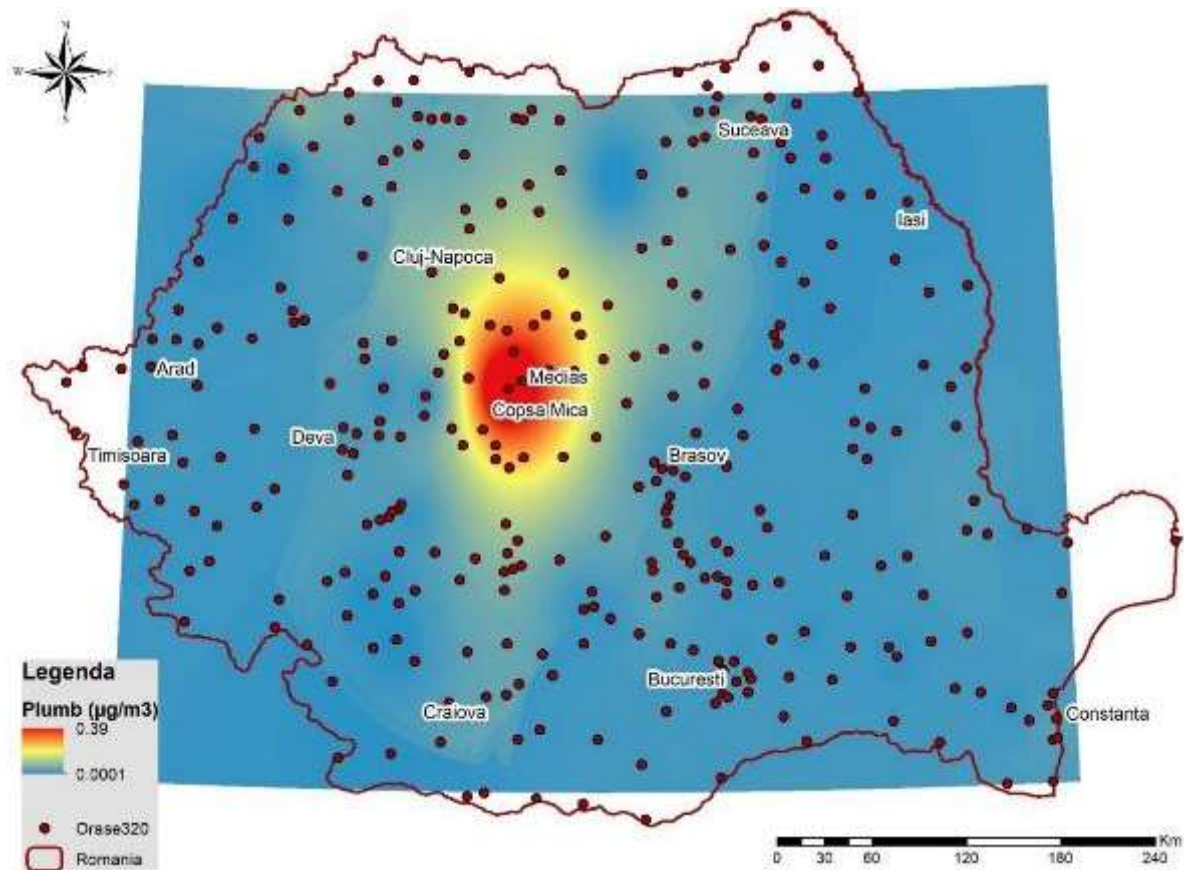
**Source: Romania's Urban Policy**

Craiova is somewhere in the middle of the national ranking regarding the concentration of this pollutant, with recorded values below the maximum permissible limits. The average annual concentration of tropospheric ozone was 50 µg/m<sup>3</sup> in 2015. On October 3, 2020, when this chapter was prepared, the daily average value recorded in Craiova was 34 µg/m<sup>3</sup>. A tropospheric ozone concentration below 120 µg/m<sup>3</sup> is considered to have a low impact on human health.

### *The concentration of lead in the air (Pb)*

Lead is a heavy metal that can be found in the urban air and is generally generated by the conventional road traffic and the industrial metallurgical activities. Lead is also one of the most dangerous heavy metals for the human body and the ecosystems. Its capacity to bioaccumulate and biomagnify makes its removal from natural and modified ecosystems extremely difficult. The highest values of this pollutant in Romania are recorded in the Copşa Mică-Mediaş area and are primarily due to the historical pollution generated by the non-ferrous metallurgical plant in Copşa Mică. The lead concentrations recorded in Craiova by the monitoring stations are below the permissible values. However, more rigorous ground-level measurements would be needed in the urban area, as ground-level lead pollution can be relatively high.

Figure 17. Concentration of lead in the air at national level, 2015



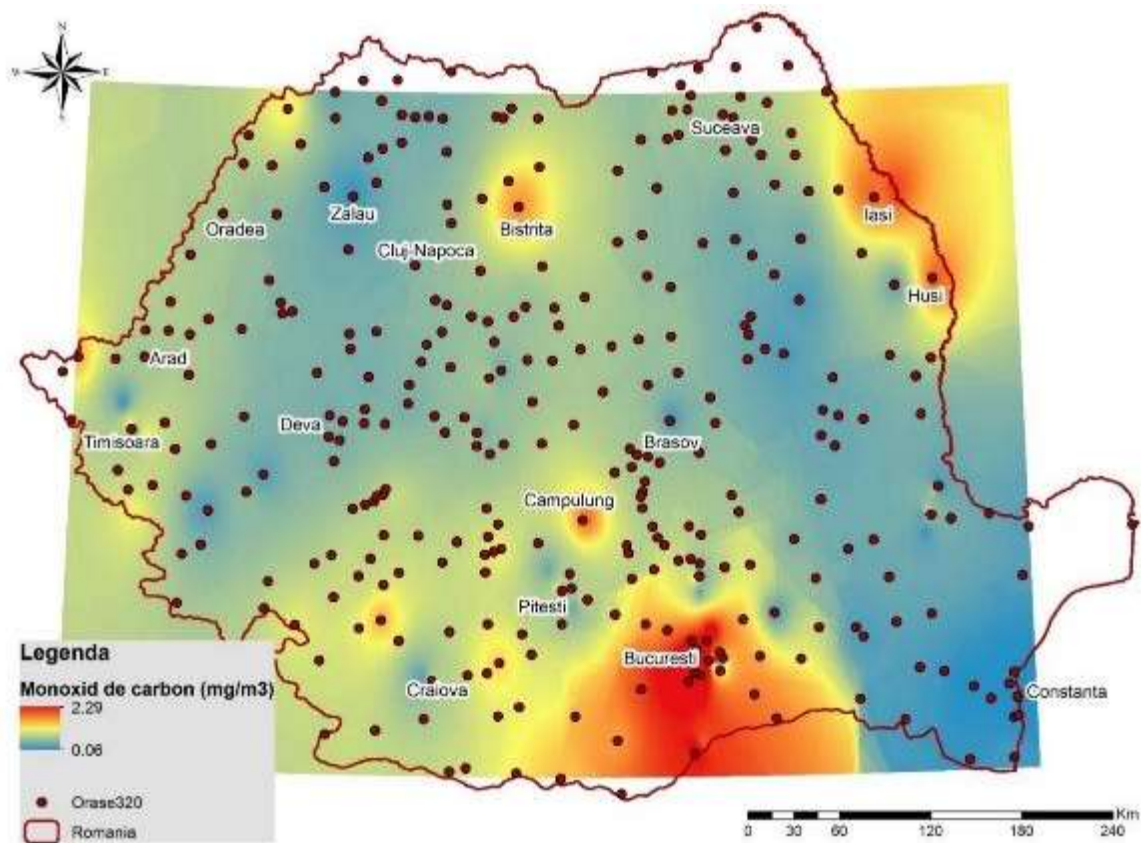
Source: Romania's Urban Policy

### The concentration of carbon monoxide (CO)

The carbon monoxide is mainly generated by heavy road traffic, with a significant impact on the health of urban ecosystems. The highest concentrations of carbon monoxide are recorded in the Bucharest urban area and in a number of urban centers with heavy road traffic. The concentration of this pollutant in Craiova is relatively low and well below the maximum permissible values. However, a closer monitoring of this pollutant would be necessary, given that the road traffic is constantly increasing in the Craiova area.

The average annual concentration of carbon monoxide in the air was approx.  $0.4 \text{ mg}/\text{m}^3$  in 2015. On October 3, 2020, when this chapter was prepared, the daily average value recorded in Craiova was  $0.7 \text{ mg}/\text{m}^3$ . A concentration of carbon monoxide in the air below  $7 \text{ mg}/\text{m}^3$  is considered to have a low impact on human health.

Figure 18. Concentration of carbon monoxide at national level, 2015



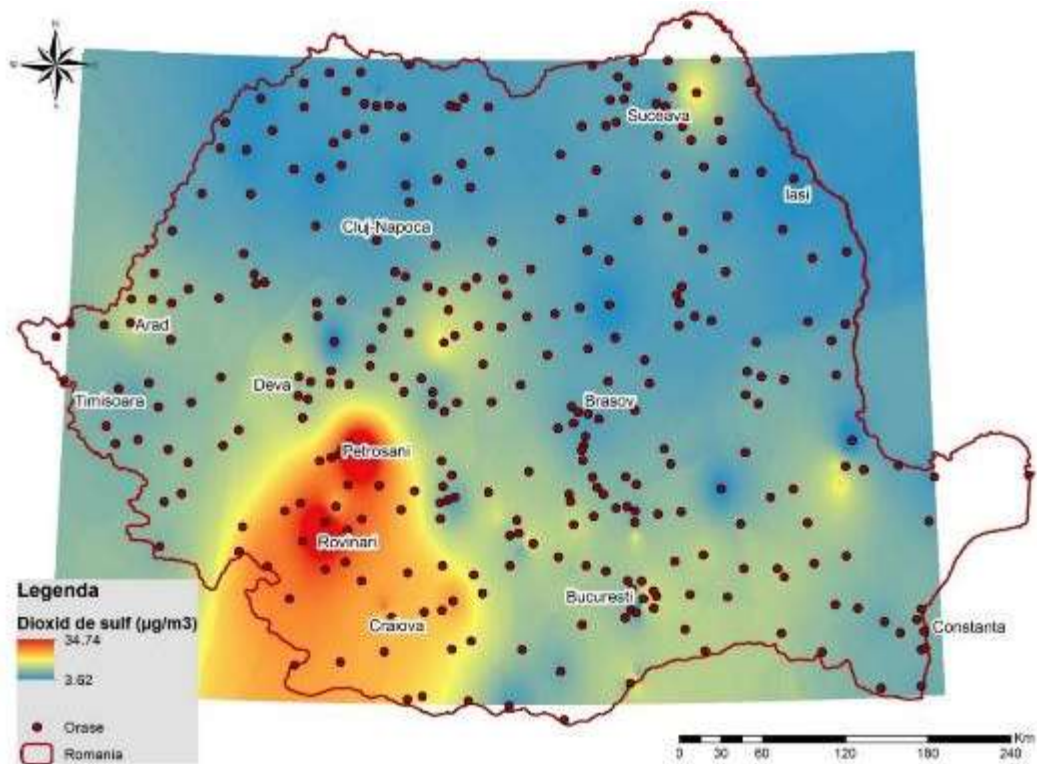
Source: Romania's Urban Policy

### The concentration of Sulphur dioxide (SO<sub>2</sub>)

The sulfur dioxide is an acidifying gas generated during the combustion of fossil fuels and the industrial processing of such fuels. A high concentration of this pollutant, correlated with a high humidity level, favors the formation of wet smog and/or acid rain, with multiple implications. The annual limit value is exceeded in the Oltenia basin (Motru-Rovinari basin, Craiova City) due to the use of low-grade coals in the very high-capacity thermal power plants in the area. The value of this indicator generally shows a significant downward trend at national level due to the increasing use of methane gas and clean fuels in the energy industry and the transport sector. Furthermore, the limitation or closure of the activities in the chemical industry contributed to the elimination of an important source of sulfur dioxide in the urban atmosphere.

The main source of sulfur dioxide pollution in Craiova is Complexul Energetic Oltenia (CEO), with its two units - Işalniţa Thermal Power Plant and Craiova II Thermal Power Plant. A number of major investments have been made by CEO in recent years, mainly in flue gas desulphurization plants. The average annual concentration of sulfur dioxide in Craiova was approx. 17 µg/m<sup>3</sup> in 2015. On October 3, 2020, when this chapter was prepared, the SO<sub>2</sub> daily average concentration was 26 µg/m<sup>3</sup>. A concentration below 125 µg/m<sup>3</sup> is considered to have a low impact on human health.

Figure 19. Concentration of sulfur dioxide at national level, 2015



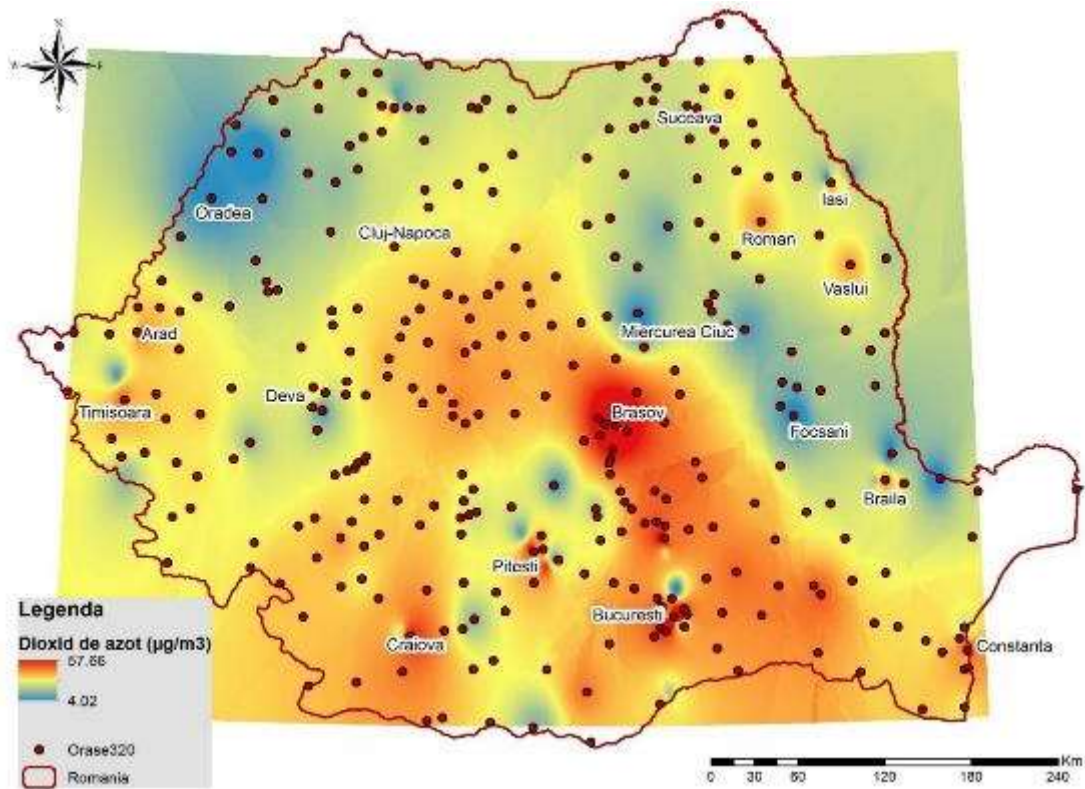
Source: Romania's Urban Policy

### The concentration of nitrogen dioxide (NO<sub>2</sub>)

The nitrogen dioxide is an acidifying gas generated during the combustion of fossil fuels and the industrial processing of such fuels, as well as by road traffic. A high concentration of this pollutant, correlated with a high humidity level, favors the formation of wet smog and/or acid rain, with multiple implications for the population health, the vegetation quality, the ecosystem productivity and the quality of buildings. Unlike the sulfur dioxide, the nitrogen dioxide is one of the main compounds related to heavy road traffic.

High values for this indicator are recorded in the urban ecosystems characterized by heavy traffic and/or industrial activities using combustion processes, and Craiova is one of these urban ecosystems. The concentration of nitrogen dioxide is exceeded in the urban areas with large population, hence the potential to significantly affect the health of the population.

Figure 20. Concentration of nitrogen dioxide at national level, 2015



Source: Romania's Urban Policy

Craiova is among the most polluted cities in terms of NO<sub>2</sub> concentration. The average annual concentration of nitrogen dioxide was approx. 34 µg/m<sup>3</sup> in 2015. On October 2, 2020, one of the air quality monitoring stations in Craiova recorded a daily average concentration of approx. 151 µg/m<sup>3</sup>. A concentration above 140 µg/m<sup>3</sup> is considered to be harmful to human health. The average annual NO<sub>2</sub> values in recent years are shown in the table below.

**Table 1. Concentrations of PM10 and NO2 recorded by the monitoring stations in Craiova**

Stație	Poluant	Unitatea de măsură	Valoare limită țintă/ Conf. Legii 104/2011			2016		2017		2018	
			Orară	Zilnică	Anuală	Concentrație medie anuală	Număr total depășiri	Concentrație medie anuală	Număr total depășiri	Concentrație medie anuală	Număr total depășiri
DJ 1	NO <sub>2</sub>	μg/m <sup>3</sup>	200	-	40	-	-	21	0	20	0
	PM10 grv	μg/m <sup>3</sup>	-	50	40	-	-	26	19	30	27
DJ 2	NO <sub>2</sub>	μg/m <sup>3</sup>	200	-	40	26.16	0	23	0	13	0
	PM10 grv	μg/m <sup>3</sup>	-	50	40	-	-	-	-	32	27
DJ 3	NO <sub>2</sub>	μg/m <sup>3</sup>	200	-	40	27.46	5	41	1	35	0
	PM10 grv	μg/m <sup>3</sup>	-	50	40	-	-	33	40	32	46
DJ 4	NO <sub>2</sub>	μg/m <sup>3</sup>	200	-	40	21.13	0	14	0	12	0
	PM10 grv	μg/m <sup>3</sup>	-	50	40	-	-	-	-	-	-
DJ 5	NO <sub>2</sub>	μg/m <sup>3</sup>	200	-	40	16.4	0	16	0	-	-
	PM10 grv	μg/m <sup>3</sup>	-	50	40	-	-	23	17	-	-

**Source: The Craiova City Air Quality Plan for 2020-2024**

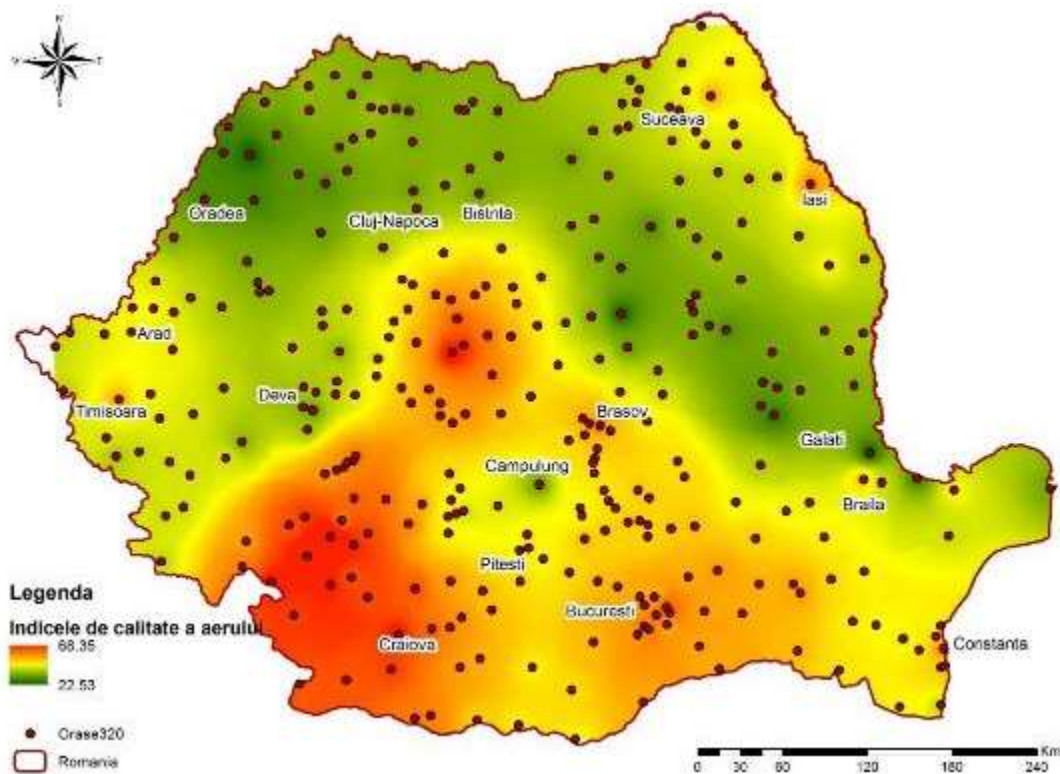
### **The specific air quality index (AQI)**

The six air pollution indicators discussed above were brought together by a team from the University of Bucharest. As a first step, the average annual concentrations for these six indicators in the urban area were split into two categories:

- category I: pollutants that do not exceed the maximum permissible concentration (MPC); the AQI is calculated according to the formula:  $AQI = 100 \cdot (C/MPC)$  (where C is the recorded concentration and MPC is the maximum permissible concentration of the pollutant).
- category II: pollutants that exceed the MPC,  $AQI = 100 \cdot (C/MPC)^n$ , where n varies between 0.9 and 1.7, depending on the degree of danger.

According to the degree of danger, the category I includes the very dangerous pollutants (ozone, n=1.7), the category II includes the dangerous pollutants (nitrogen oxides, lead, n=1.3), the category III includes the moderately dangerous pollutants (sulfur dioxide, particulate matter, n=1) and the category IV includes the least dangerous pollutants (carbon monoxide, n=0.9). First, the index is calculated for each pollutant, then the global AQI is calculated as the arithmetic mean of all monitored pollutants from all the assessment points. The index was determined based on the values extracted for each city/town from the interpolated maps for each air quality indicator. The map below shows the air pollution level in each city/town in Romania. Craiova has the worst air quality of all major cities in Romania and ranks 4th in the urban hierarchy (after Rovinari, Copșa Mică, Motru) as a general level of pollution.

Figure 21. Specific air quality index at national level, 2015



Source: Romania's Urban Policy

### Share of the maximum permissible concentration exceedance

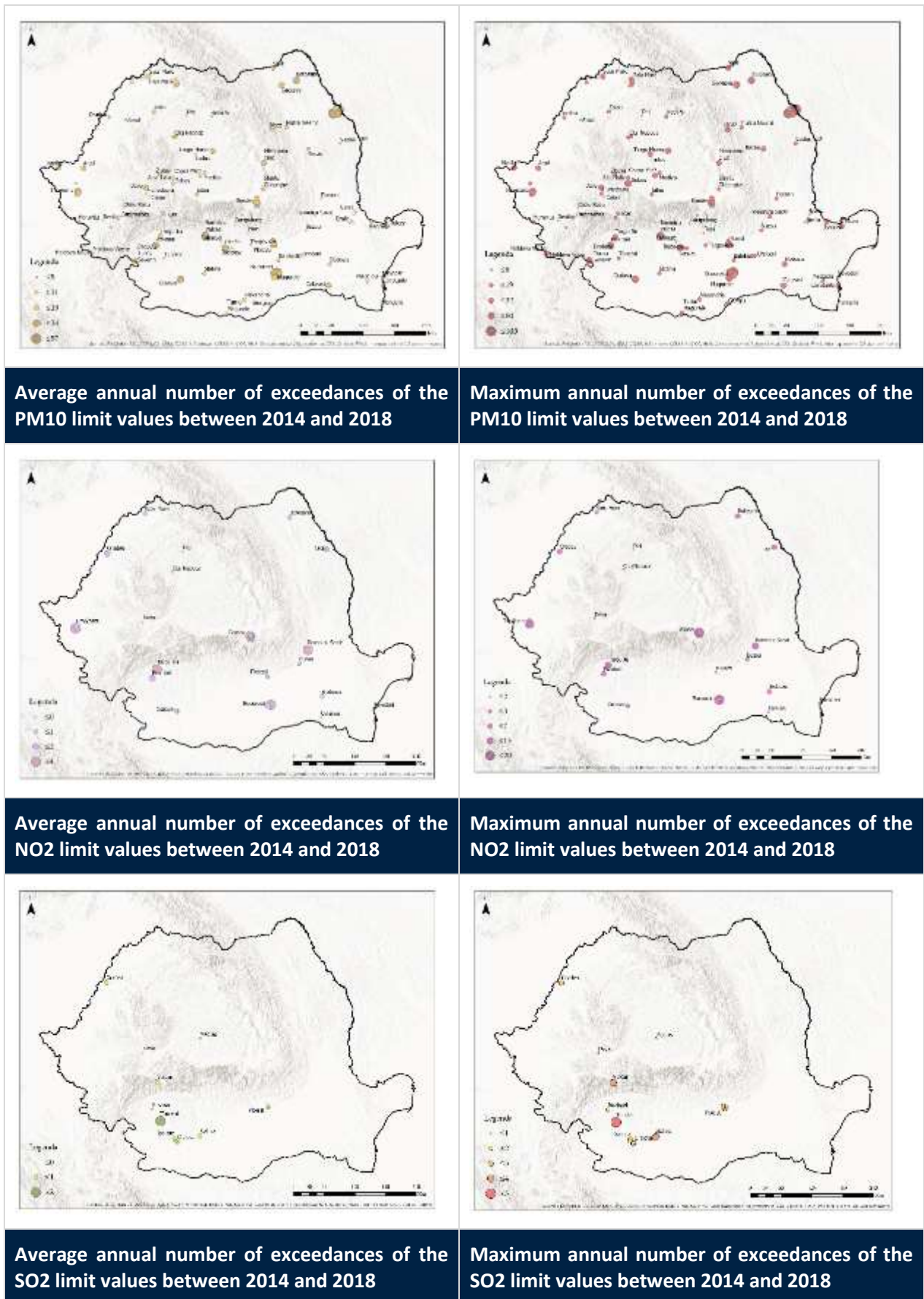
The authorities established maximum limits for all six sources of air pollution discussed above. Appropriate measures, such as eliminating the sources, upgrading the plants or developing the green-blue infrastructure must be implemented in case these limits are exceeded. These limits are:

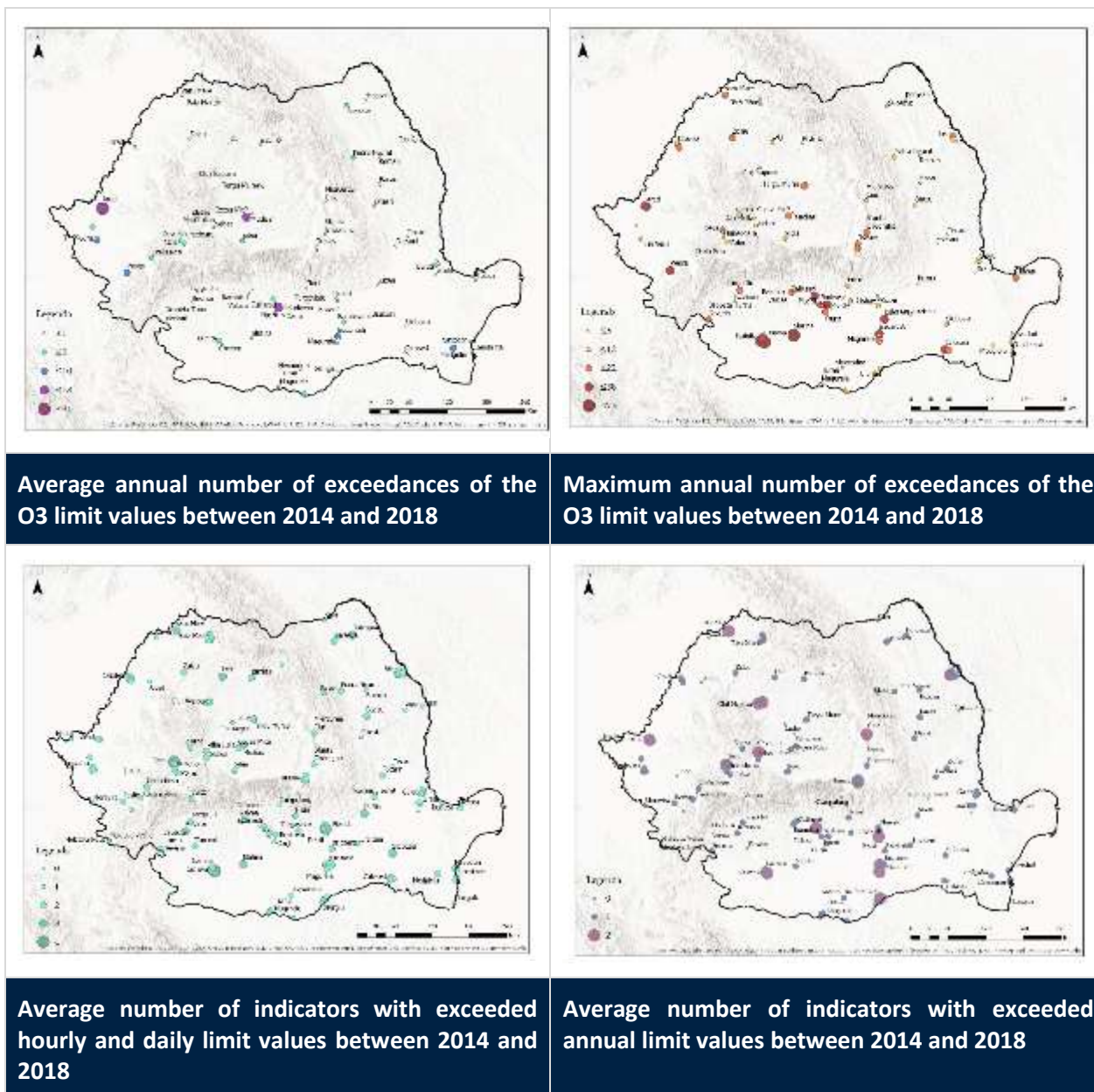
- Limit values for sulfur dioxide in ambient air: a daily limit value of  $125 \mu\text{g}/\text{m}^3$ , which must not be exceeded more than three times in a calendar year, and an hourly value for the protection of human health of  $350 \mu\text{g}/\text{m}^3$ , which must not be exceeded more than 24 times in a calendar year.
- Limit values for nitrogen dioxide in ambient air: an annual limit value of  $40 \mu\text{g}/\text{m}^3$  for the protection of human health and an hourly limit value of  $200 \mu\text{g}/\text{m}^3$ , which must not be exceeded more than 18 times in a calendar year.
- Limit values for particulate matter ( $\text{PM}_{10}$ ) in ambient air: a daily limit value of  $50 \mu\text{g}/\text{m}^3$  for the protection of human health and an annual limit value of  $40 \mu\text{g}/\text{m}^3$ .
- Limit values for ozone in ambient air: a limit value measured over an 8-hour period of  $120 \mu\text{g}/\text{m}^3$  for the protection of human health, which must not be exceeded more than 25 times in a calendar year, and a maximum daily 8-hour mean of  $120 \mu\text{g}/\text{m}^3$ , which must never be exceeded.

In Romania, the highest values were recorded for particulate matter. The maps below show the cities and towns in Romania with exceeded maximum values of the air quality measurement indicators.

Craiova recorded exceedances of the maximum values for all indicators and is one of the worst performing cities in Romania in terms of the number of exceedances of the maximum hourly, daily and annual values.

**Figure 22. Cities and towns in Romania with exceeded maximum values of different air quality measurement indicators between 2014 and 2018**





Source: Romania's Urban Policy

### Soil quality and pollution

The main indicator used for estimating soil pollution is the level of contamination with various chemicals. The term “contaminated sites” refers to a well-defined area where soil contamination has been confirmed. The impact on the ecosystems and the population may be severe enough to require remediation measures, especially in relation to the current or future use of the area. The remediation of the contaminated sites results in the total elimination or the reduction of the negative impact. The term “potentially contaminated site” refers to any area where a soil contamination is suspected, but there is no confirmation thereof and detailed investigations must be carried out to check for any significant impact. The table below lists the different impact levels of soil contamination.

Table 2. Definition of the impact levels of soil contamination

Level	Definition	Specific elements
Level 0	Sites with no negative effects on human health or the environment	No impact, no restrictions

Level 1	Sites where the environmental factors are contaminated to a tolerable level, with no significant negative effects on human health and the ecosystems	Minor impact, no restrictions; under monitoring
Level 2	Sites with significant negative effects on human health and the ecosystems if the current use is replaced by a more sensitive one; monitoring may be required	No significant impact if the current use is maintained; restricted use
Level 3	Sites with significant negative effects on the health of the population and the ecosystems under the current use conditions; rehabilitation and risk reduction activities are needed	Significant impact; intervention is required

4 main steps must be completed in order to rigorously determine the impact level of soil contamination: preliminary study; preliminary investigations; detailed field research of the site; implementation of risk reduction measures. The emissions of hazardous substances from local sources may adversely impact the soil and water quality. The contaminated site management is aimed at assessing the adverse effects and promoting measures to meet the environmental standards according to the applicable legal requirements. No legal standards for soil quality have been set at EU level, but some European Environment Agency member countries have set their own targets. The legislation is generally focused on preventing new cases of contamination and sets out targets for the greening of those sites where the environmental standards have not been met.

It is important to mention here that 4 of the 216 contaminated sites identified in Romania are located on the territory of the Craiova urban area. Moreover, 92 % of the polluting material deposited on the territory of Romania is deposited on the territory of the Craiova Metropolitan Area. The greening of the four contaminated sites (Electrocentrale Craiova II, Işalniţa Right Bank, Işalniţa Left Bank, Petrom sludge pit) will probably be one of the most important environmental actions carried out both in Craiova and in Romania in general.

**Table 3. The largest contaminated sites in Romania**

Name	Type	Economic agent	County	Volume (mil.m3)
<b>VALEA MĂNĂSTIRII</b>	SLAG AND ASH DUMP - valley dump	ELECTROCENTRALE BUC SUC. CRAIOVA II	DJ	48680
<b>IŞALNIŢA 2</b>	CET IŞALNIŢA RIGHT BANK DUMP - plain dump	SC ELECTROCENTRALE BUC SUC. IŞALNIŢA	DJ	22100
<b>IŞALNIŢA 1</b>	RIGHT BANK DUMP - plain dump	SC ELECTROCENTRALE BUC SUC. IŞALNIŢA	DJ	16600
<b>GHERCEŞTI</b>	SLUDGE PIT - plain dump	SNP PETROM SCHELA EXTR. CRAIOVA	DJ	10000
<b>VALEA MARE</b>	INDUSTRIAL WASTE LANDFILL	SC UZINA DE AGENT TERMIC ŞI ALIMENTARE CU APĂ MOTRU	GJ	6800
<b>CALAFAT</b>	INDUSTRIAL WASTE LANDFILL - plain dump	SC UZINA TERMICĂ CALAFAT	DJ	1260
<b>VALEA ŞESEI</b>	TAILING POND - valley dump	S.C. CUPRU MIN S.A. ABRUD	AB	66
<b>BEJAN</b>	SLAG AND ASH DUMP - valley dump	S.C. ELECTROCENTRALE DEVA	HD	36.4
<b>CICANI</b>	INDUSTRIAL WASTE LANDFILL - plain dump	SE ROVINARI	GJ	33.8
<b>GOVORA 2</b>	SLUDGE PITS - plain dump	U.S. GOVORA	VL	29
<b>BOZÂNTA REMIN</b>	TAILING POND - plain dump	REMIN	MM	26

<b>VALEA CEPLEA I</b>	INDUSTRIAL WASTE LANDFILL - valley dump	SE TURCENI	GJ	25
<b>BETEREGA</b>	INDUSTRIAL WASTE LANDFILL - plain dump	SE ROVINARI	GJ	23.6
<b>MUREȘ 1</b>	SLAG AND ASH DUMP - plain dump	S.C. ELECTROCENTRALE DEVA	HD	20.7
<b>FAGUL CETĂȚII - BĂLAN POND NO. 4</b>	TAILING POND - valley dump	CNCAF DEVA FILIALA BĂLAN	HR	11.2
<b>GOVORA 1</b>	GOVORA SLAG DUMP - valley dump	CET - GOVORA	VL	11
<b>ROVINA ȚĂRĂȚEL</b>	TAILING POND - slope dump	FILIALA BRADMIN BRAD	HD	11
<b>VALEA ȘTEFANCEI II</b>	TAILING POND - valley dump	S.C. CUPRU MIN S.A. ABRUD	AB	11

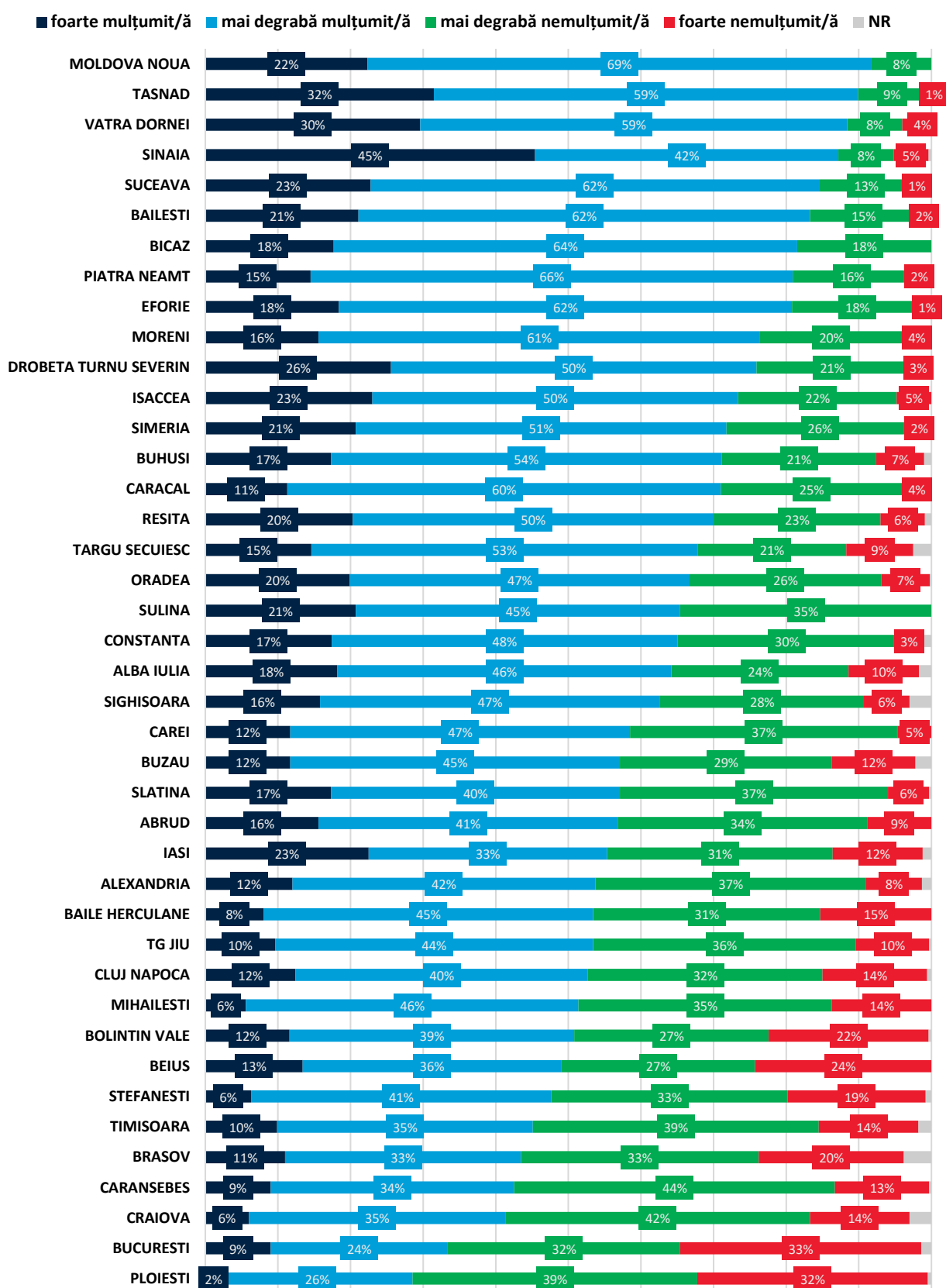
Another area with soil pollution is the Mofleni Ecological Landfill, in the eastern part of Craiova.

### Noise quality and pollution

Although it might not seem so at first sight/hearing, the noise level is a significant urban stress factor. As a rule, the noise pollution is particularly keenly felt in larger cities.

As part of the 2020 Urban Barometer, conducted for the development of the Romania's Urban Policy, the inhabitants of the Romanian cities and towns were asked to rate how satisfied they were with the noise level in their city/town. About half of the urban population (57 %) say they are satisfied with the noise level, with a higher degree of satisfaction in the small localities (68 % in the localities with less than 20,000 inhabitants) and a lower degree of satisfaction in the localities with over 100,000 inhabitants (48 %). The inhabitants of Craiova, together with those of Bucharest and Ploiești, are among the most dissatisfied with the noise level in their city, 42 % of the respondents stating that they are dissatisfied and 14 % very dissatisfied:

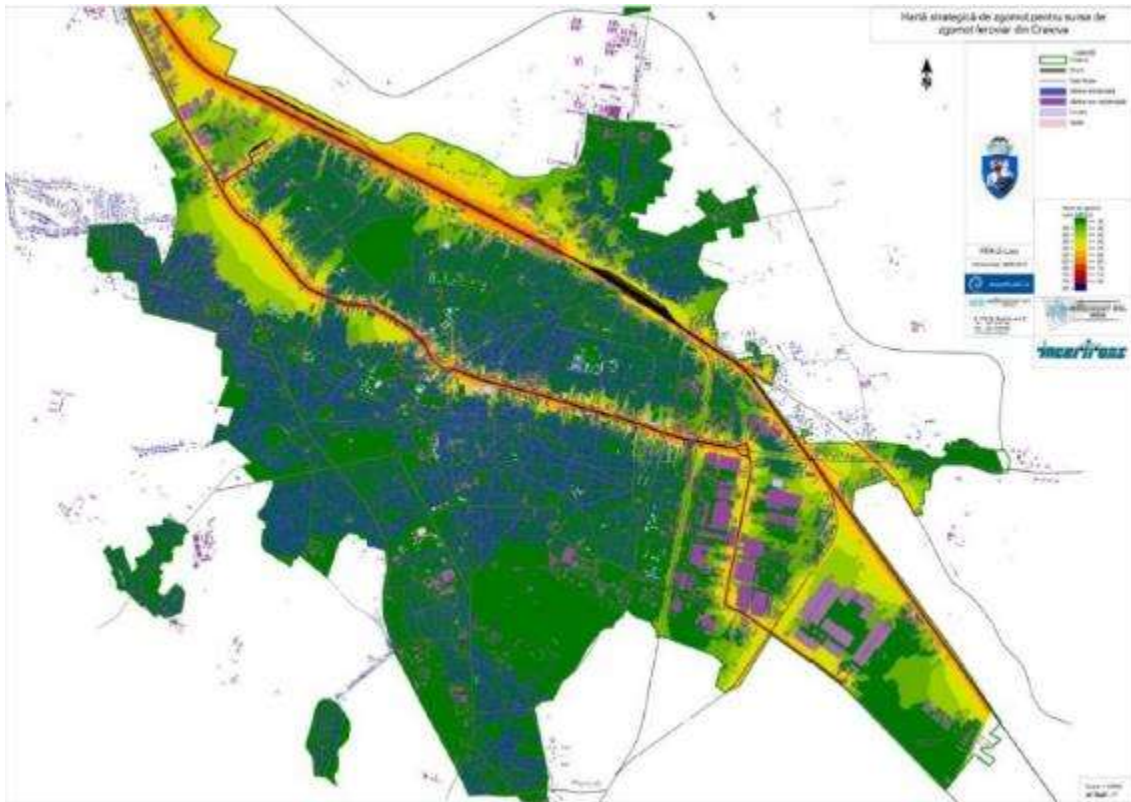
Figure 23. Urban Barometer. Answer to the question: How satisfied are you with the noise level in your city?



Source: Romania's Urban Policy

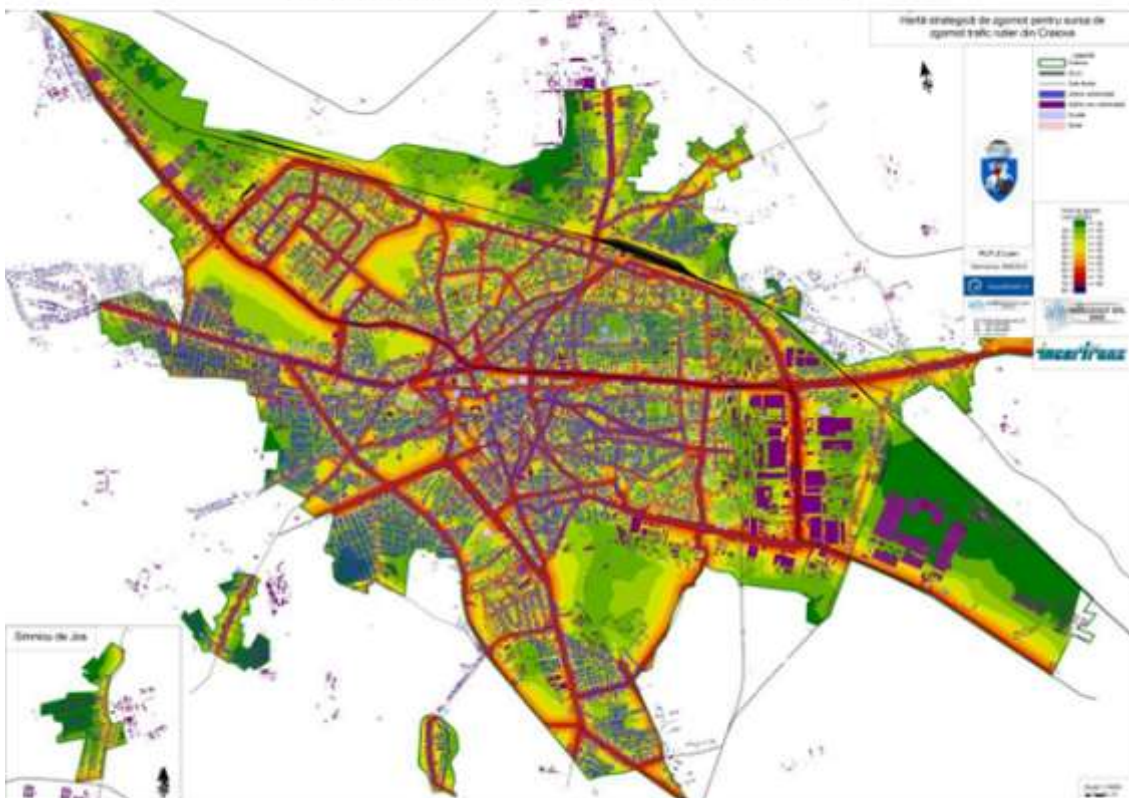
Figure 24. The noisiest areas in Craiova

Noise source - railway traffic (exposed people)



Source: Urban Environment, Health and Quality of Life, State of the Environment County Report, 2014

Sursa de zgomot-traficul rutier (persoane expuse)



Sursa : Doc. Mediul Urban, Sănătatea și Calitatea Vieții, Raportul Județean Privind Starea Mediului, Anul 2014

## CLIMATE CHANGE AND ENVIRONMENTAL RISKS

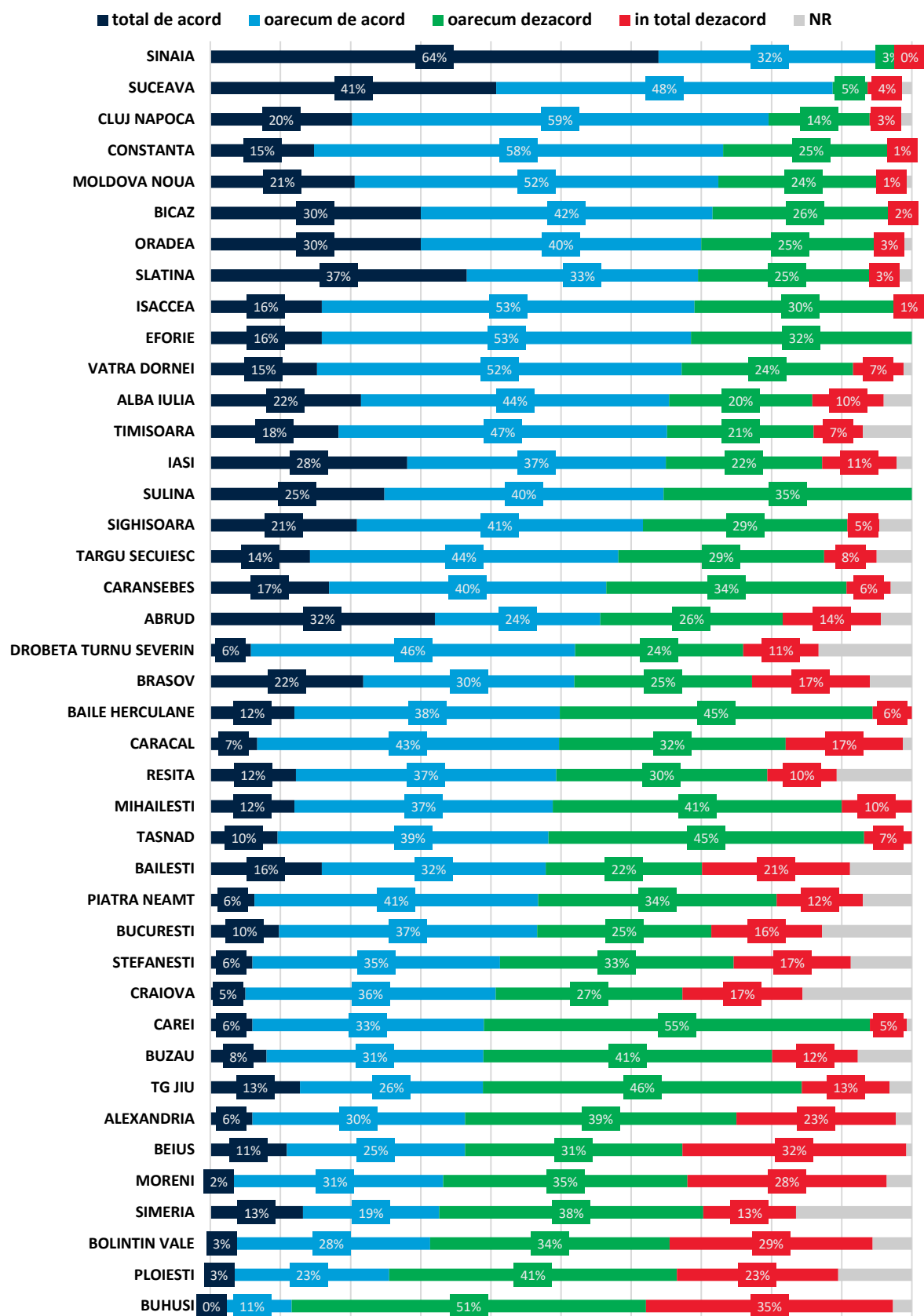
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### Climate change

Climate change has become an important topic for the Romanian citizens, and, according to the 2020 Urban Barometer, conducted for the development of the Romania's Urban Policy, 53 % of the urban population in Romania believe that the cities/towns that they live in "are committed to fighting climate change". Compared to the inhabitants of other cities/towns, the people living in Craiova believe that the local authorities could do more to fight climate change - only 5 % are completely satisfied with what is already being done and 36 % are somewhat satisfied.

The data collected in recent years clearly demonstrate that the temperature is rising in Romania, and some areas are more affected by this phenomenon than others. In the following pages, we will discuss how climate change affects Craiova.

Figure 25. Urban Barometer. Answer to the question: To what extent do you agree with the statement that your city/town is committed to fighting climate change (energy efficiency, clean transport)?



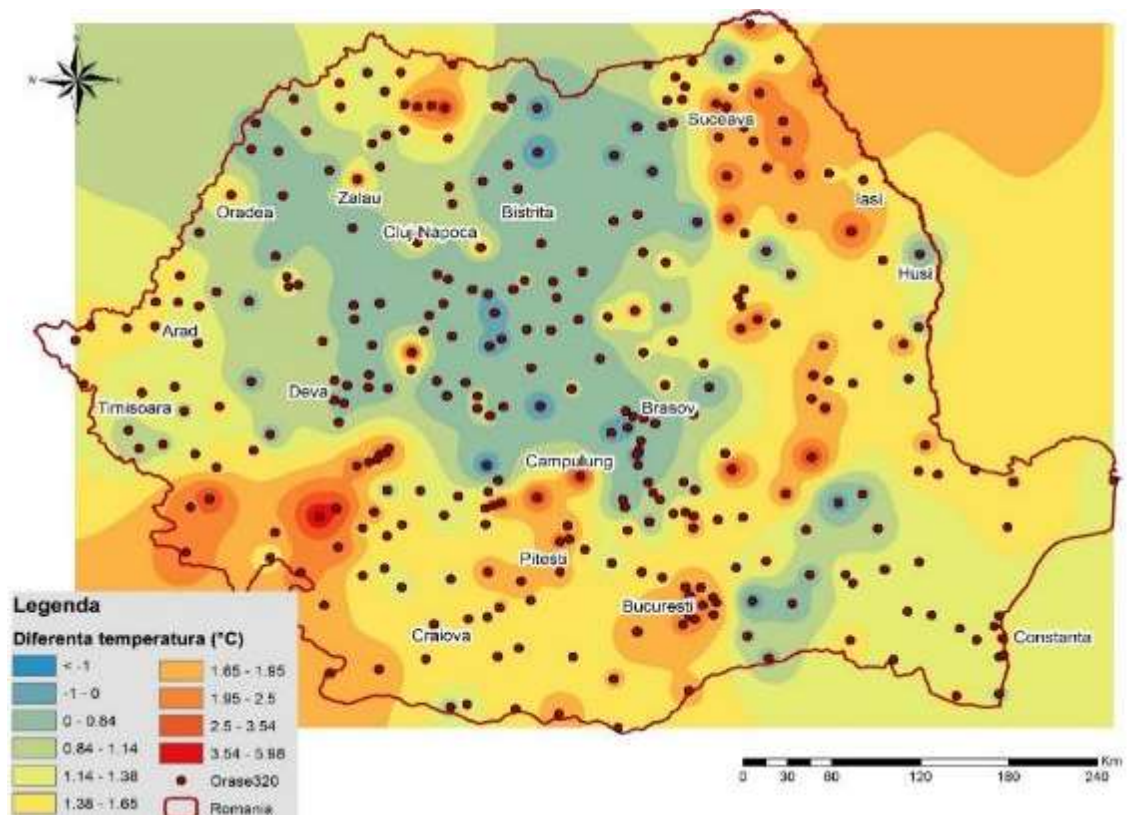
Source: Romania's Urban Policy

### Average annual air temperature

Cristian Ioja, Professor at the University of Bucharest, carried out a comprehensive analysis of the difference between the average temperature in 2015 and the multiannual average temperature for the period 1960-2000, for all the cities and towns in Romania. The main data sources used for the analysis were <http://www.worldclim.org/version1> for the 1960-2000 multiannual average and <http://en.tutiempo.net/climate/romania.html> for the average annual air temperature values in 2015.

The air temperature is obviously directly linked to climate change and is a variable that changes as a result of global warming. The air temperature is one of the clearest indicators of climate change. The map below shows the areas in Romania where the biggest differences from the average temperature for the period 1960-2000 have been recorded.

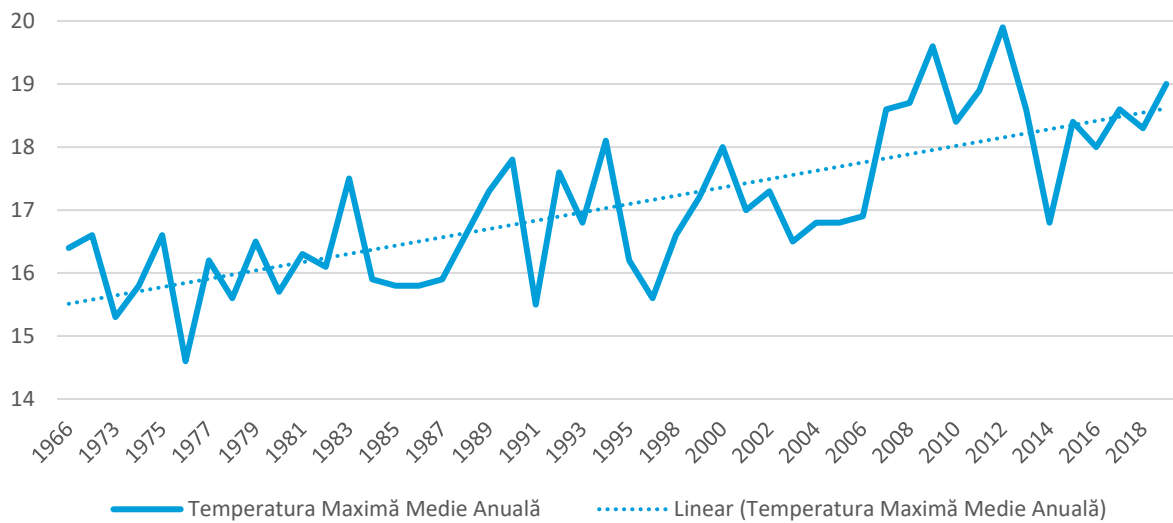
**Figure 26. Difference between the air temperature in 2015 and the average temperature for the period 1960-2000**



*Source: Romania's Urban Policy*

In 2015, the average temperature in Craiova was 1.3 °C higher than that for the period 1960-2000. The average temperature in 2019, the most recent recorded data, was 1.7 °C higher than that for the period 1960-2000. On the other hand, the average temperature for the period 2015-2019 was 1.22 °C higher than that for the period 1960-2000. As far as the average annual maximum temperature is concerned, it is constantly increasing at an alarming rate.

**Figure 27. Average annual temperature in Craiova**

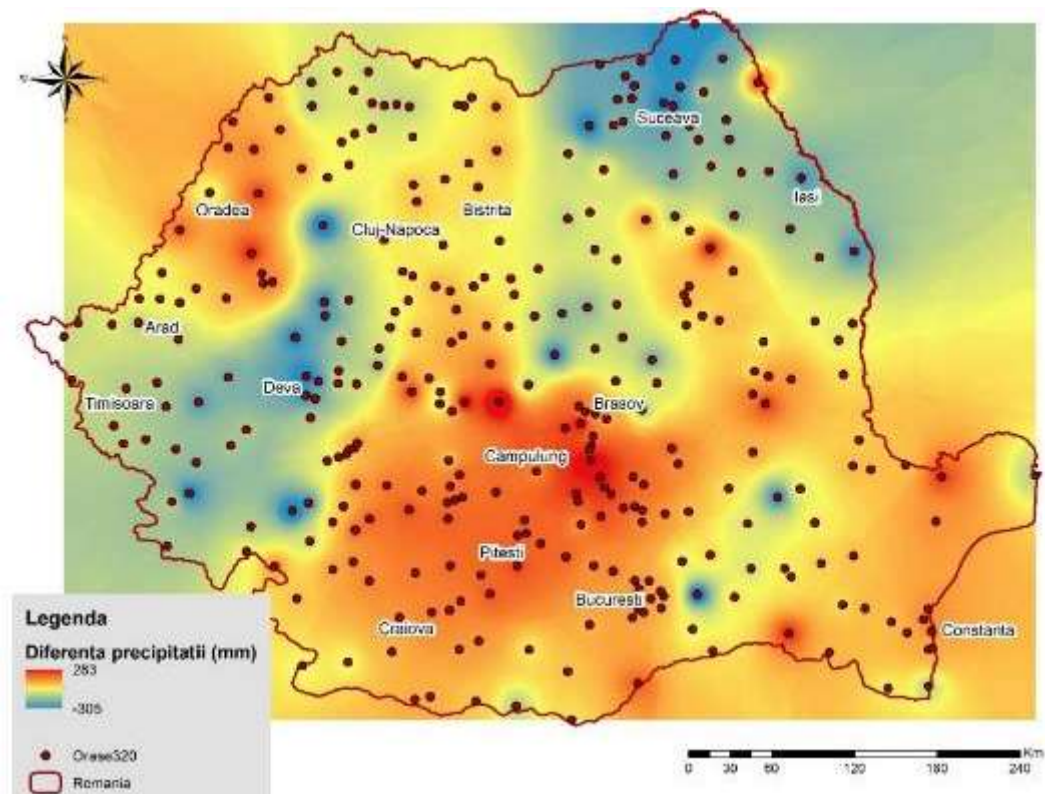


**Source: Authors' own processing of historical data for Romania available at <http://en.tutiempo.net/climate/romania.html>**

#### **Average annual amount of atmospheric precipitation**

The same data sources used to identify the temperature dynamics were used to determine the changes in terms of the amount of precipitation in 2015 as compared to the average value for the period 1960-2000. Obviously, just like the air temperature, the amount of atmospheric precipitation is also influenced by climate change. The atmospheric precipitation is putting pressure on the urban environments (rainwater must be properly managed so as not to affect the urban infrastructure), but it also brings major benefits by providing the water that is needed for the optimal functioning of the green infrastructures, by cleansing the atmosphere, by supplying water to some hydrogeological structures, etc. The map below shows that Craiova City is part of an area with average changes in the amount of atmospheric precipitation.

**Figure 28. Difference from the average annual amount of atmospheric precipitation in the Romanian cities and towns**



*Source: Romania's Urban Policy*

### Urban heat islands

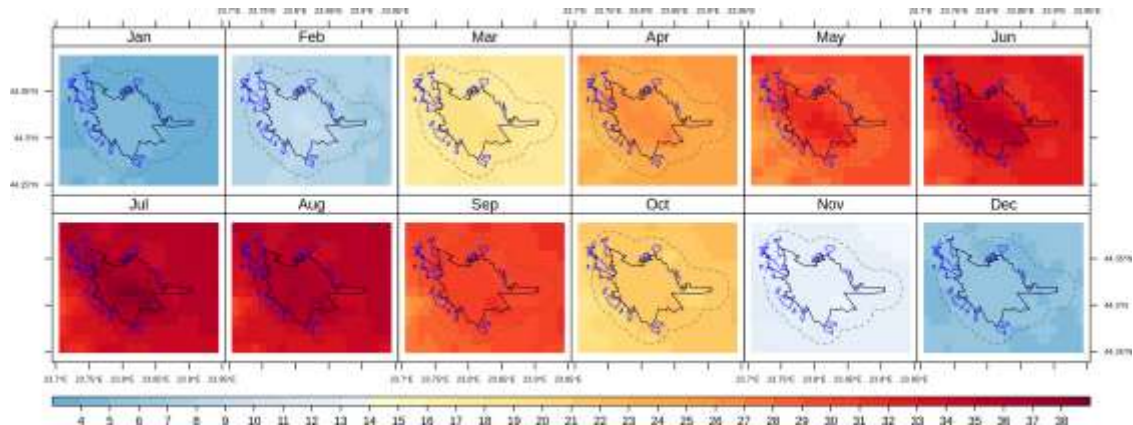
The changes in temperature, as well as the temperature-related and climate risk are exacerbated at the urban level by the characteristics of the built environment, which can lead to the creation of urban heat islands, where the temperature exceeds the average value in the area. In simple terms, the urban heat island is the increase in temperature in the urban areas compared to the surrounding rural areas and is calculated as the difference between the urban temperature (UT) in the city/town and the rural temperature (RT) in the rural and natural areas around it. The available technology makes it possible to measure these temperature differences with the help of satellite images.

Data on the heat islands for 263 cities and towns have been collected for the development of the Romania's Urban Policy. These cities and towns have been selected based on the relevant area for the creation of urban heat islands and the availability of satellite images. The analysis covered the period between 2000 and 2019; 27,063 LST MODIS MxD11A1 images have been processed, from which the images with LST values that cover at least 50 % of the surface of each analyzed city/town have been selected.

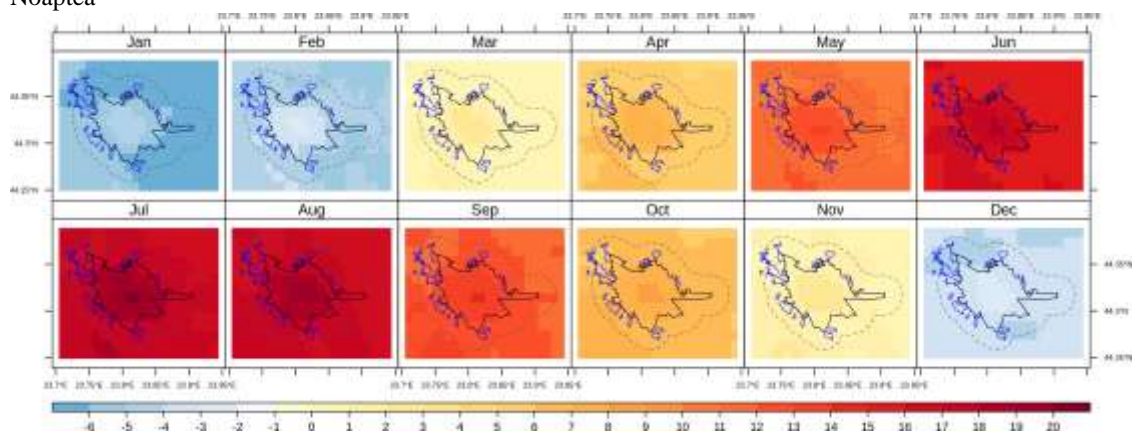
A detailed methodology for the estimation of the urban heat islands is included in a support report on the Urban Policy. We will include herein some steps that reveal the relevant dynamics for Craiova. The maps below show the analysis of the monthly spatial distribution of the land surface temperature (LST) in Craiova, during the day and at night. The buffer used to quantify the urban heat island (dotted line) around Craiova's built perimeter (solid line) is also highlighted.

**Figure 29. Monthly spatial distribution of the land surface temperature in Craiova**

Ziua



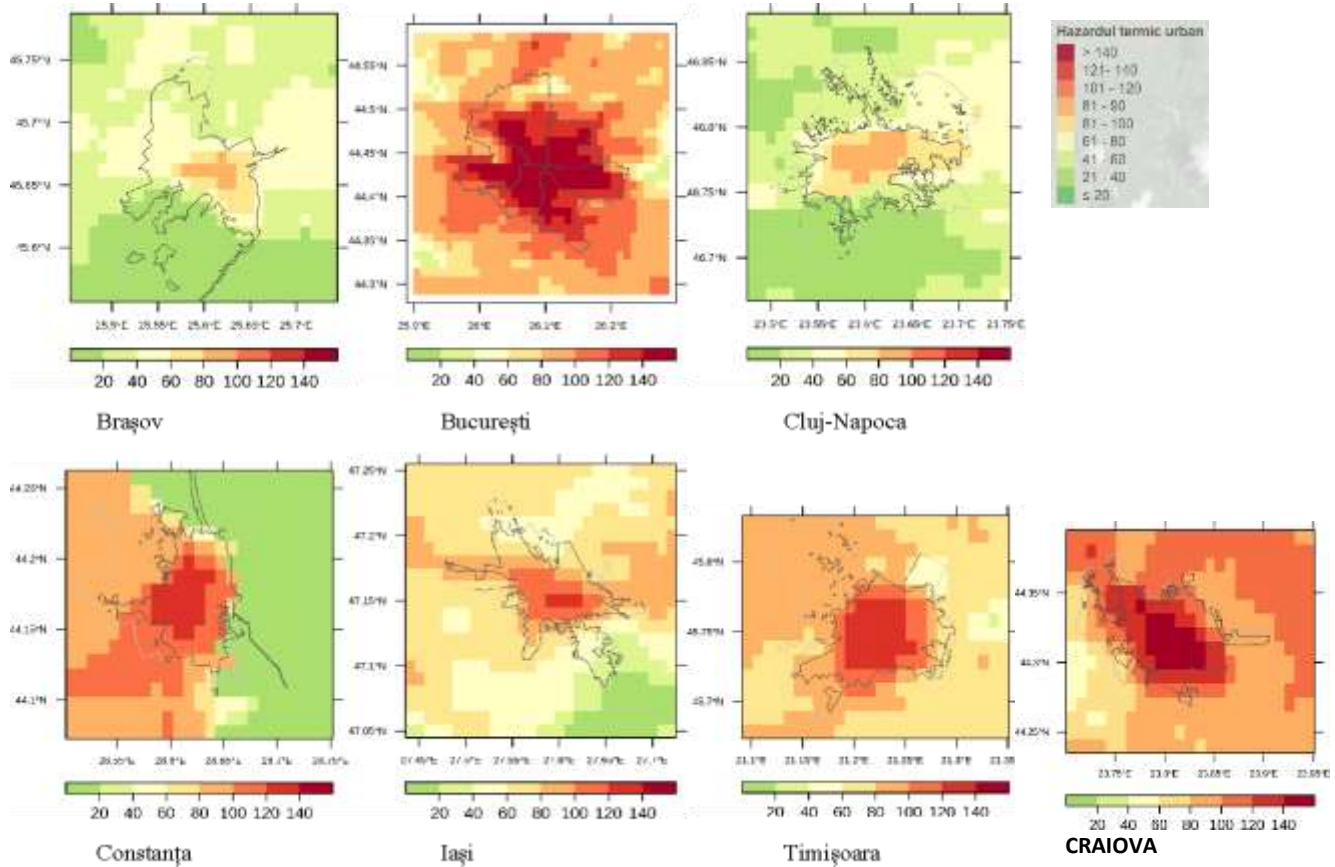
Noaptea



**Source: Romania's Urban Policy**

Of course, the intensity of the urban heat islands varies from one city/town to another; the heat island effect tends to be more intense in larger cities and those with extended built area. The temperature-related hazard (HT) is an important aspect to consider in this respect; this was calculated based on the number of times that the land surface temperature exceeded 32 °C during the day or 22 °C during the night for each pixel covering the built area of the analyzed cities/towns. HT was analyzed at country level and the classification took into account the highest and lowest values in all the analyzed cities/towns. The figure below shows the temperature-related hazard for Braşov, Bucharest, Cluj-Napoca, Constanţa, Iaşi, Timişoara and Craiova. Net geographical differentiations can be observed. The highest values for the temperature-related hazard are recorded in the southern regions (120-160 in the Bucharest area, 80-140 in Craiova, 120-140 in Constanţa), while the lowest values are recorded in the mountainous regions (60-80 in Braşov) and (80-100 in Cluj-Napoca).

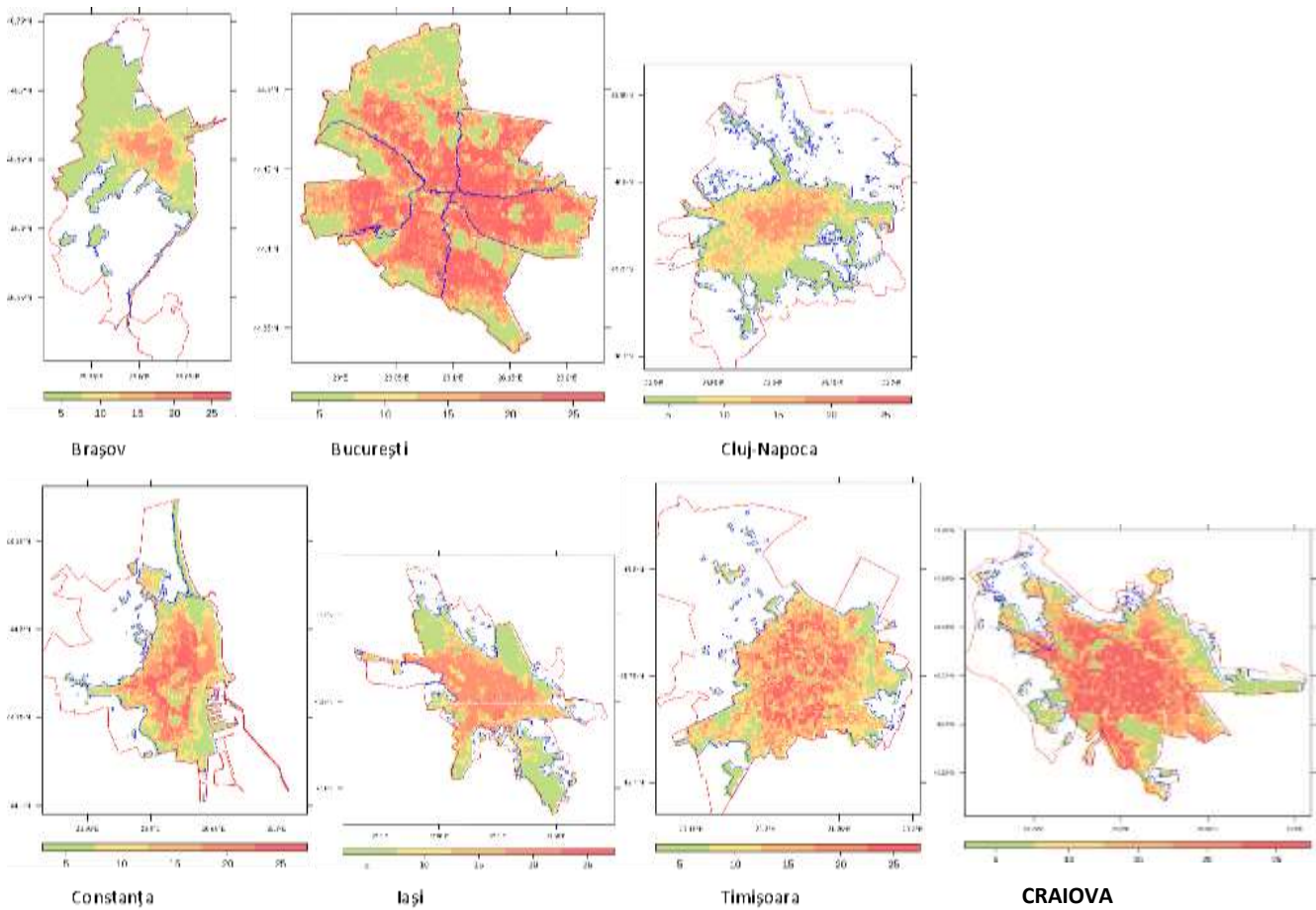
**Figure 30. Temperature-related hazard in different Romanian cities**



**Source: Romania's Urban Policy**

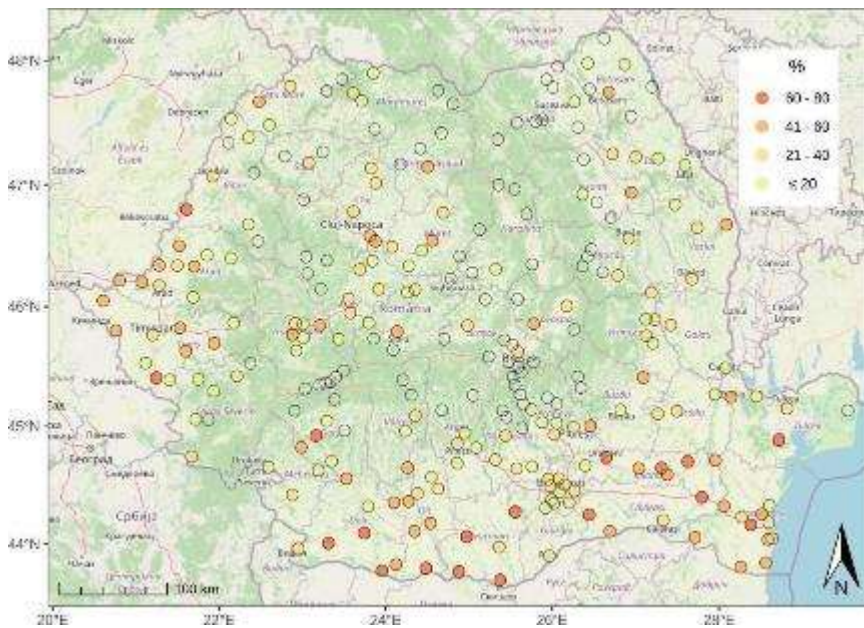
The temperature-related risk (RT) is another dimension covered by the analysis. It is a product of the temperature-related hazard and the vulnerability determined by the population density and the characteristics of the urban built perimeter. As a rule, the higher the value or the share of the temperature-related hazard, the population density and the built perimeter, the greater the risk of heat waves and extreme temperatures. The figure below shows the temperature-related risk for Braşov, Bucharest, Cluj-Napoca, Constanţa, Iaşi, Timişoara and Craiova.

**Figure 31. Temperature-related risk in different Romanian cities and towns**



**Source: Romania's Urban Policy**

It is worth mentioning here that Craiova City has the highest temperature-related risk (see below) of the 263 cities and towns in Romania, except for Bucharest, for which data have been collected. More specifically, 87.5 % of the inhabitants of Craiova are exposed to a high or very high temperature-related risk. This state of affairs obviously requires some interventions (e.g. increasing the green areas - parks, roofs, public areas) to help reduce the temperature-related risk.

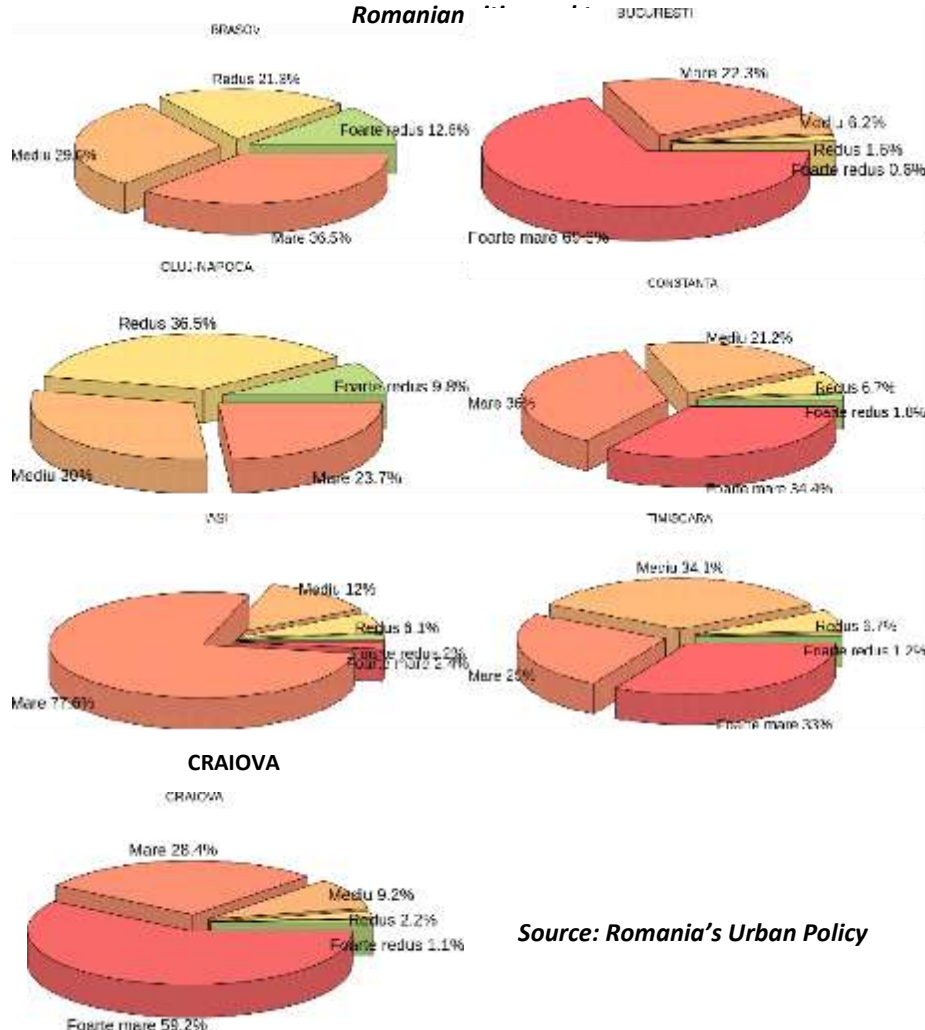


**Figure 32. The share of the resident population exposed to a moderate temperature-related risk in the Romanian cities and towns**

**Source: Romania's Urban Policy**

The figure below shows the full share of the population affected by different risk categories for Craiova compared to Braşov, Bucharest, Cluj-Napoca, Constanţa, Iaşi and Timişoara.

**Figure 33. The share of the resident population exposed to the temperature-related risk in different Romanian**



**Source: Romania's Urban Policy**

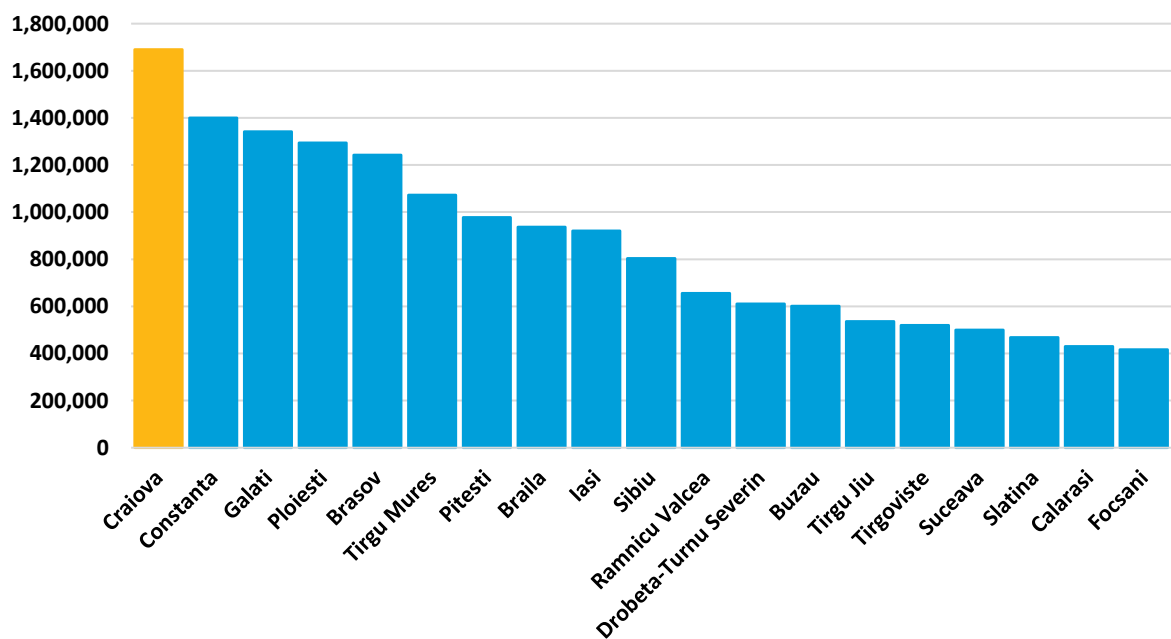
## How does Craiova contribute to climate change?

### Reduction of CO<sub>2</sub> emissions in Craiova

Greenhouse gases are among the main contributors to climate change and include a number of gases generated by motorized transport, industrial processes and other human activities (heating, electricity generation, etc.). Greenhouse gases include: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), sulfur hexafluoride (SF<sub>6</sub>), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

Bucharest is clearly the main generator of greenhouse gases in Romania. The second largest volume of greenhouse gases is generated in Craiova (see the chart below). The main sources of greenhouse gases are the Işalniţa and Craiova II thermal power plants, as well as the companies located in the city's industrial sites. Road traffic is also a substantial and growing source of greenhouse gas emissions. The data collected by CESTRIN (Center for Road Technical Studies and Informatics) show that Craiova ranks 9th at national level in terms of the estimated daily number of vehicles transiting the locality. These data highlight the need to develop an urban ring road to divert heavy and transit traffic outside the city, but they also raise the issue of investing more in the non-motorized (pedestrian and bicycle) transport infrastructure, as well as in the public transport infrastructure. According to the 2020 Urban Barometer, conducted for the development of the Romania's Urban Policy, only 18 % of the inhabitants of Craiova use the means of public transport on a regular day, compared to 48 % in Ploieşti, 46 % in Constanţa, 44 % in Iaşi and 42 % in Cluj-Napoca.

**Figure 34. Estimated amount of greenhouse gases generated by the cities in Romania (except Bucharest)**



Source: Romania's Urban Policy







### Alternative resources for energy production

The Craiova IUDS 2024 includes a more detailed discussion on the potential of the Craiova Functional Urban Area to generate energy from alternative sources. We will not go into analytical details, but we will present the main conclusions of the current strategy:

- The Craiova Growth Pole Functional Urban Area is part of a region with great biomass energy potential, with a technical biomass energy potential in the Romanian Plain of 126,639 TJ (about 24.4 % of the entire country’s potential). The very high biomass energy potential is primarily due to the use of biomass from agriculture, since the entire southern region of the country is focused on agriculture.
- Due to its geographical position, the Craiova Growth Pole Functional Urban Area, part of the South-West Oltenia Region, has one of the greatest exploitable solar energy potential (solar energy is one of the most renewable resource), falling within the red area. Solar farms have been built in the Filiași, Mischii and Pleșoi areas.
- The localities crossed by the Jiu river have the highest micro-hydropower potential: Filiași, Brădești, Ișalnița, Breasta, Bucovăț, Craiova, Malu Mare, Țuglui and Teasc.
- The southern part of the Craiova Growth Pole Functional Urban Area has a wind energy potential that can be used in a cost-efficient manner, with an average annual wind velocity in the area of around 6 m/s. The average annual wind velocity in the localities situated in the northern part of the area is around 4 m/s.

### Renewable energy sources

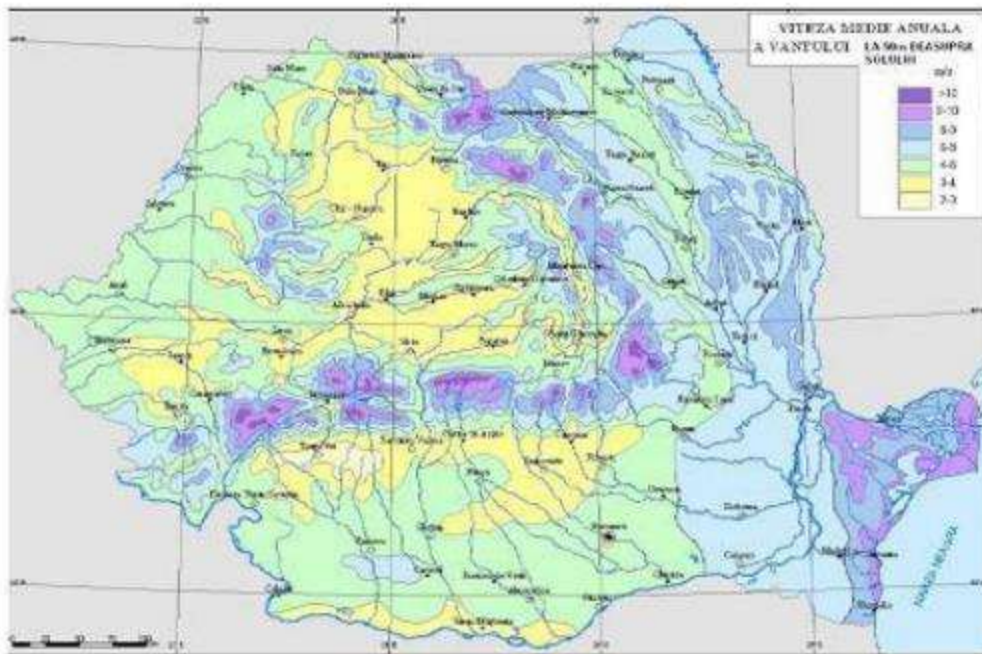
Figure 35. Renewable energy sources, technologies and applications

Energie solară	Energie eoliană	Energie oceanică	Energie hidroelectrică	Energie geotermală	Bioenergie
					
<p><u>Source:</u> <b>Sun</b></p> <p><u>Technologies:</u> <b>Photovoltaic systems, solar thermal plants</b></p> <p><u>Applications:</u> <b>Electricity generation, heating and cooling</b></p>	<p><u>Source:</u> <b>Wind</b></p> <p><u>Technologies:</u> <b>Wind turbines</b></p> <p><u>Applications:</u> <b>Electricity generation</b></p>	<p><u>Source:</u> <b>Waves, tides</b></p> <p><u>Technologies:</u> <b>Tidal dams and barrages</b></p> <p><u>Applications:</u> <b>Electricity generation</b></p>	<p><u>Source:</u> <b>Water</b></p> <p><u>Technologies:</u> <b>Hydroelectric plants</b></p> <p><u>Applications:</u> <b>Electricity generation</b></p>	<p><u>Source:</u> <b>Earth</b></p> <p><u>Technologies:</u> <b>Geothermal plants, heat pumps</b></p> <p><u>Applications:</u> <b>Electricity generation, heating and cooling</b></p>	<p><u>Source:</u> <b>Biomass, waste</b></p> <p><u>Technologies:</u> <b>Combustion of biomass, biogas plants, biofuels</b></p> <p><u>Applications:</u> <b>Electricity generation, heating and cooling, transport</b></p>

### Wind energy potential

Craiova has the potential to harvest wind energy, but this potential is rather low due to the average wind velocity in the area of 4-6 m/s.

**Figure 36. Areas in Romania with wind energy potential**

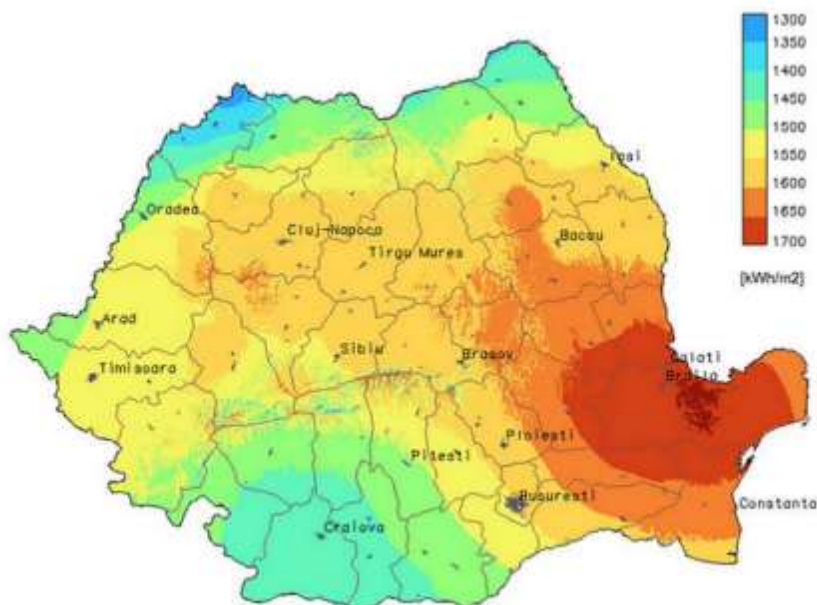


Source: [http://www.minind.ro/domenii\\_sectoare/energie/studii/potential\\_energetic.pdf](http://www.minind.ro/domenii_sectoare/energie/studii/potential_energetic.pdf)

### Solar energy potential

Craiova is located in an area with a very high solar energy potential, which makes the option of building solar farms infrastructure here worth considering.

**Figure 37. Areas in Romania with solar energy potential**



Source: European Commission, <http://re.jrc.ec.europa.eu/pvgis/countries/europe.htm>

## Biomass energy potential

Biomass refers to all forms of plant or animal organic matter, as well as substances produced by the biological development, so basically the biodegradable part of products, waste and residues from agriculture, forestry and related industries, as well as the biodegradable part of industrial and municipal waste. The map below shows the biomass energy potential in Romania; Dolj county has a low biomass potential from forestry, but a high biomass potential from agriculture.

**Figure 38. Biomass energy potential in Romania**

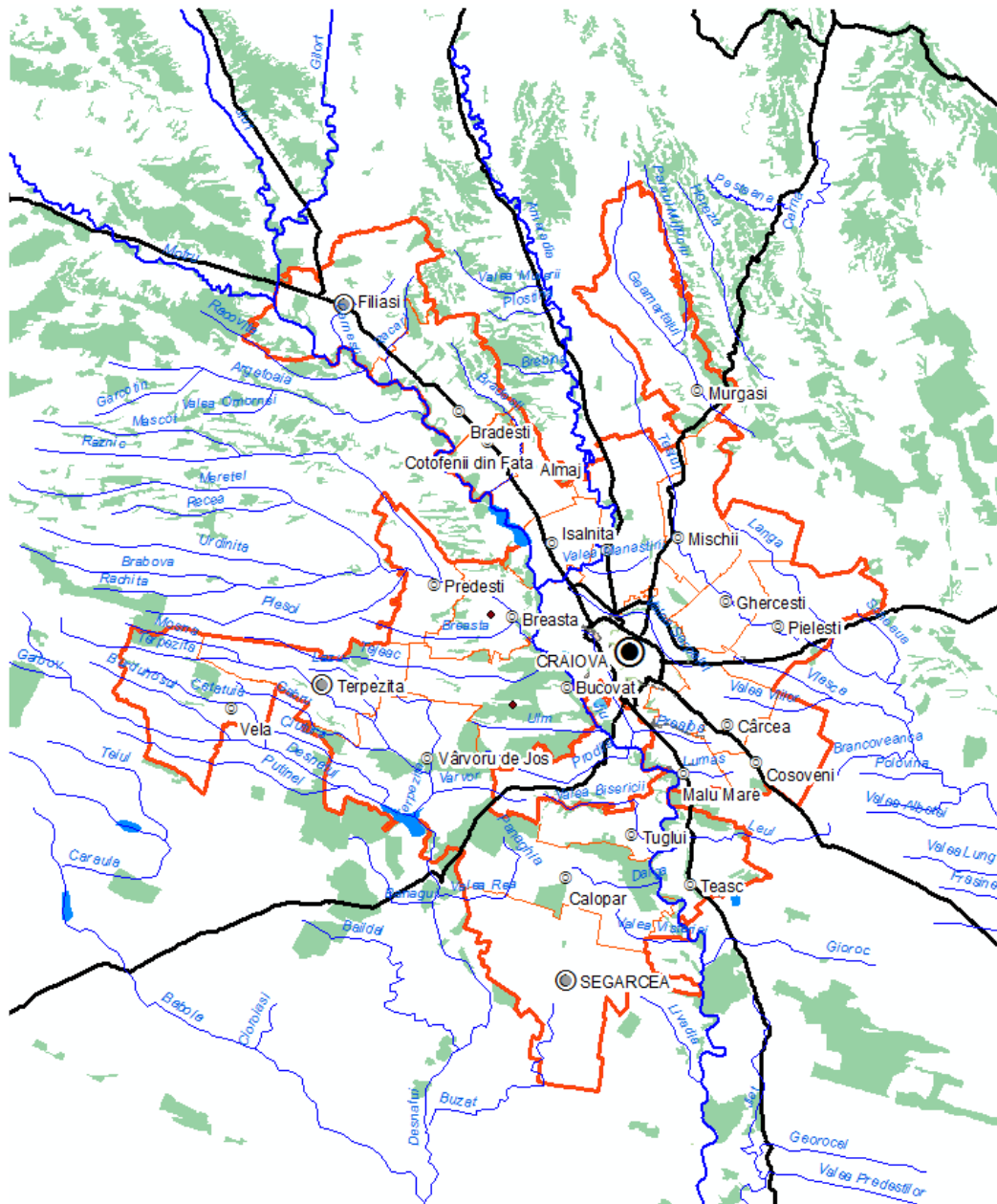


## Natural and anthropogenic risks

### Hydrography and flood risk

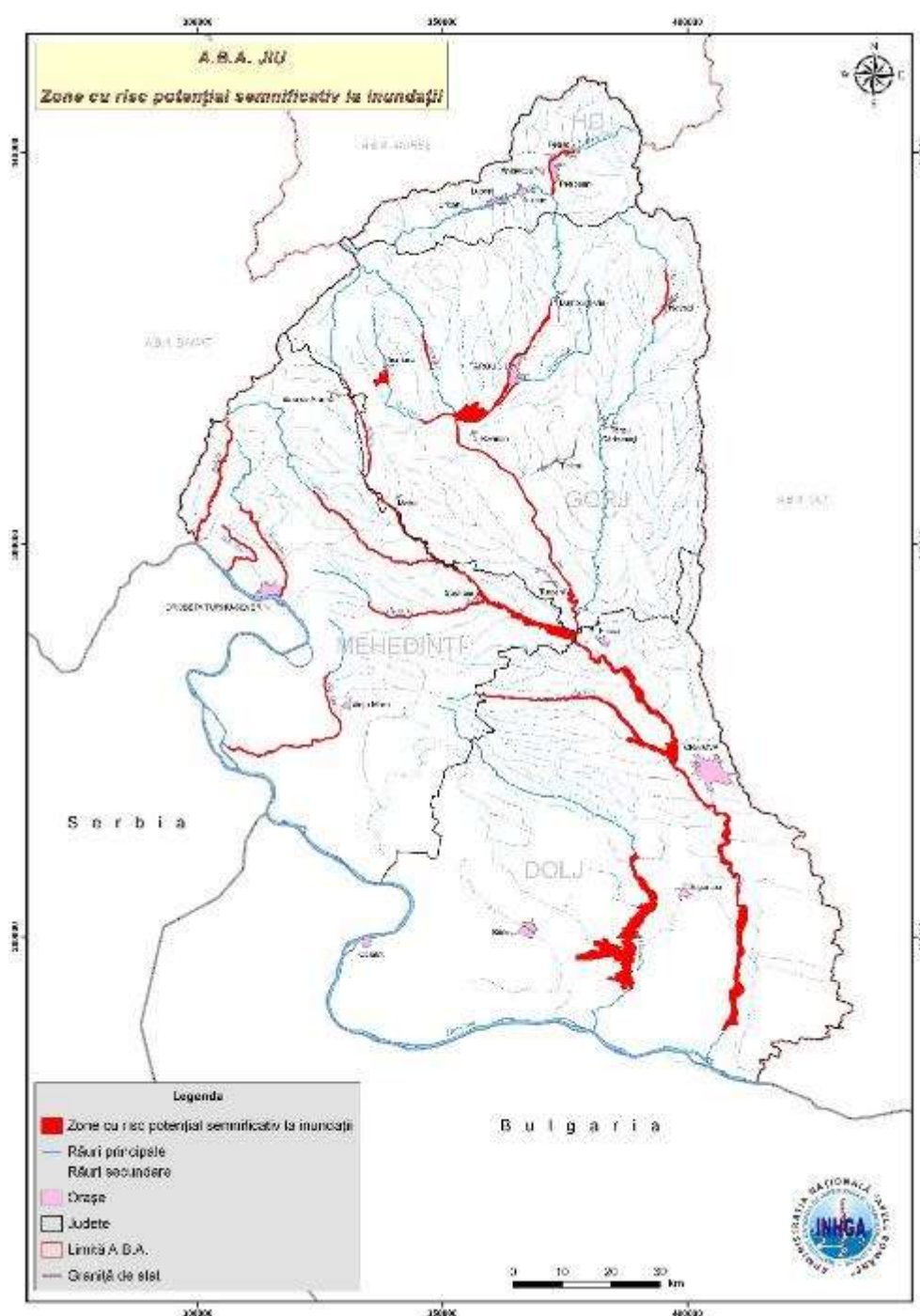
IUDS 2020 includes a more detailed analysis on hydrography and lakes, so we will not go into these details here. The map below provides an overview of the network of rivers and lakes in the Craiova Metropolitan Area and the potential for the development of the green-blue infrastructure in the CMA. The main river in the area is the Jiu river, while the main lakes include: the Ișalnița reservoir, the Fântânele lake in the Vârvoru de Jos commune, the Hanul Doctorului lake and the Tanchiștilor lake in Craiova City.

**Figure 39. Hydrology of the Craiova Metropolitan Area**



Source: Craiova Growth Pole IUDS 2020

**Figure 40. Areas of potential significant flood risk, A.B.A. Jiu**

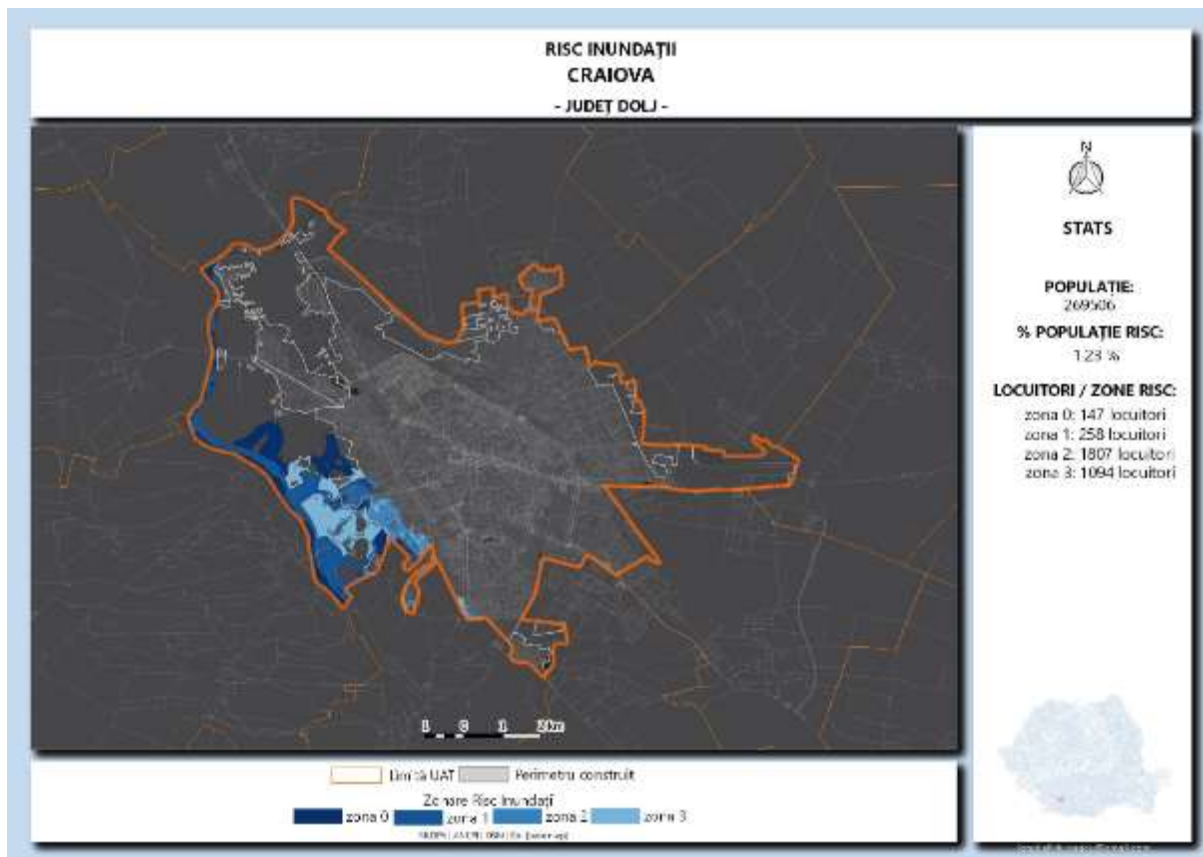


**Source: National Administration "Romanian Waters"**

The flood prone areas are also important when discussing the hydrographic network. Development restrictions should normally apply in these areas. The map above shows the areas of potential significant flood risk in southwest Romania.

This analysis was detailed for the Craiova territorial administrative unit, in order to determine the flood prone areas and the affected population. The analysis used medium flood risk ranges (recurrence interval  $\geq 100$  years), broken down into the four risk classes (0, 1, 2, 3). A relatively low share of the population is at risk of being affected by floods - approx. 1,100 inhabitants. However, the flood prone area is relatively large and limits Craiova's potential for urban expansion.

**Figure 41. Flood prone areas, Craiova TAU**

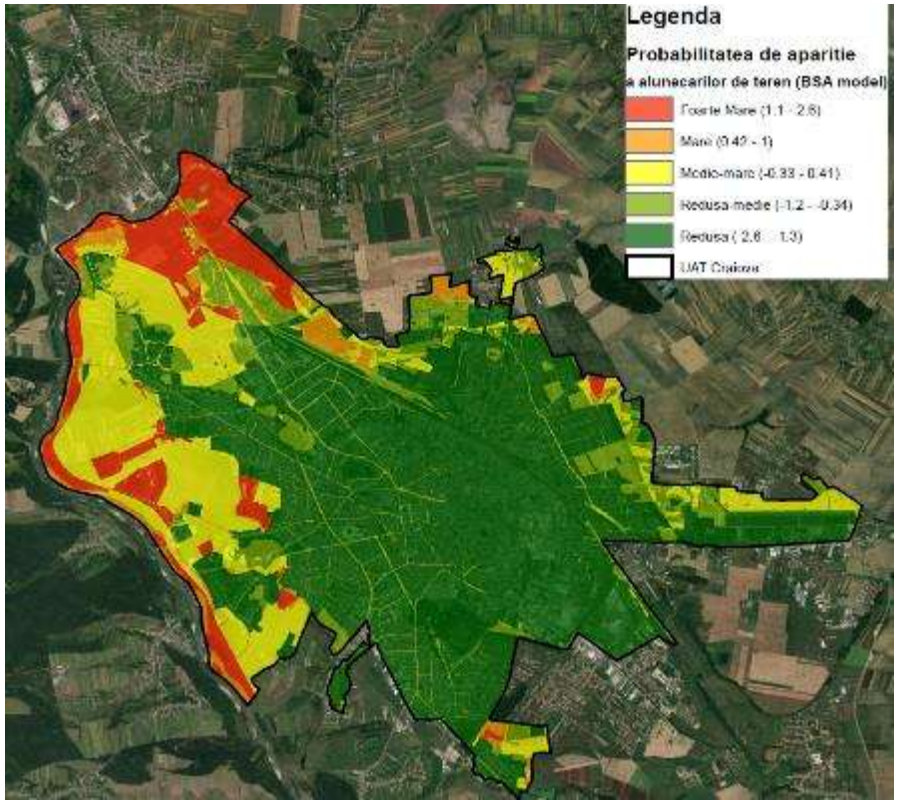


**Source: Romania's Urban Policy**

### **Risk of landslides**

IUDS 2020 discusses about the types of soil in the Craiova Metropolitan Area. It is also important to analyze the extent to which these soils affect Craiova's development prospects. Indeed, if we look at the landslide-prone areas, we can see that much of the undeveloped areas in Craiova fall into this category.

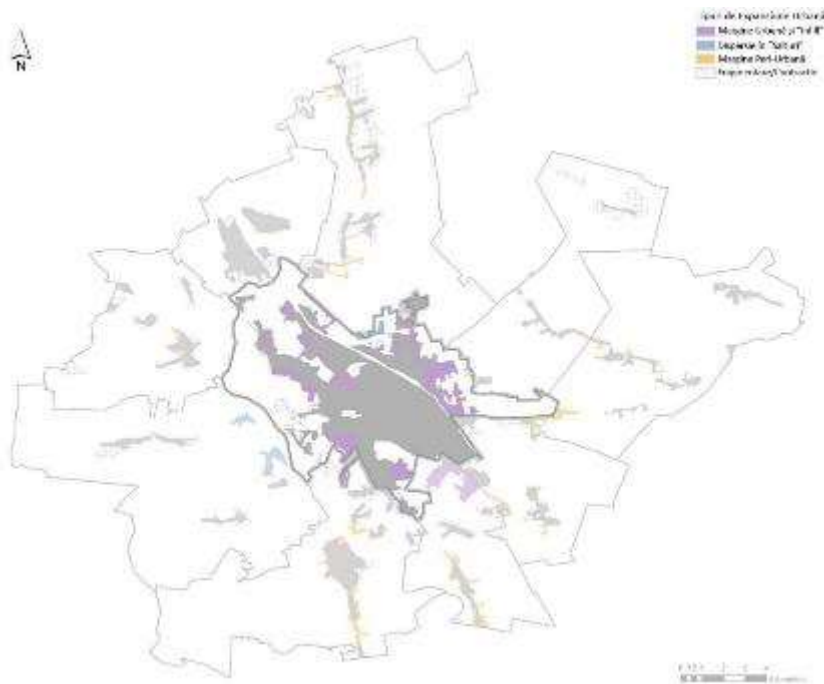
If we consider both the flood and the landslide prone areas, we can see that Craiova's urban expansion is guided towards the south and the southeastern part of the city. These dynamics are also confirmed by the current data regarding Craiova's urban expansion in recent years (see the maps below).



**Figure 42. Landslide-prone areas in Craiova**

*Source: Romania's Urban Policy*

**Figure 43. Craiova's expansion areas**

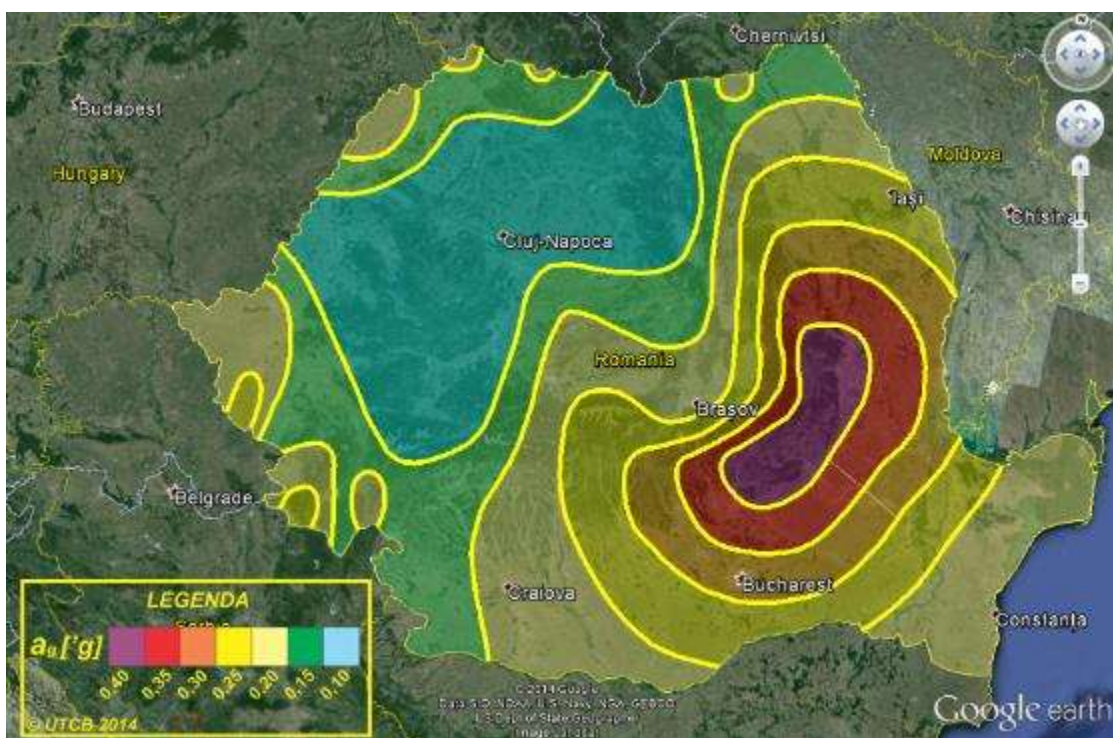


*Source: Romania's Urban Policy*

## Seismic risk

The National Institute for Earth Physics has developed a seismic zoning map of Romania that pinpoints the highest seismic risk areas. Craiova is included in the seismic intensity zone 6 (see classification below), although the impact of the 1977 earthquake would rather place Craiova in the seismic risk class 9. During the 1977 earthquake, several hundred people were injured, and dozens killed. The buildings damaged by the 1977 earthquake include: the University of Craiova building, the Art Museum, the Museum of Oltenia, the Romanian Communist Party's Dolj County Committee headquarters, the Nicolae Bălcescu High School, the Frații Buzești High School, Casa Băniei, the București Hotel, the Faculty of Mechanical Engineering, the Faculty of Agriculture, the Court of Dolj County, the Puppet Theater, Casa Universitarilor, the Palace Hotel, the Aman County Library, the buildings on Unirii Street and in the Madona Dudu – Mercur area<sup>1</sup>.

**Figure 44. Seismic risk areas in Romania**



**Source: Seismic Risk Assessment Research Center, Technical University of Civil Engineering Bucharest**

Although no clear cyclical pattern of high-intensity earthquakes was observed in Craiova between 1700 and 2019, it is nonetheless important to prepare for an earthquake like the one in 1977. Particular attention should be paid to implementing measures to mitigate the consequences of an earthquake. Of particular importance will be the compliance with clear building standards and regulations, the identification and consolidation of vulnerable buildings (special priority should be given to the educational infrastructure), the dissemination of earthquake response procedures and the development of rapid response systems.

<sup>1</sup> Boengiu, Sandu. 2019. The City of Craiova: Study of Urban Geomorphology. The University of Craiova - Faculty of Sciences.

**Figure 45. MSK seismic risk scale**

Intensity degree		Medvedev–Sponheuer–Karnik seismic intensity scale MSK 64
1	Not perceptible	The intensity of the vibration is below the human sensitivity threshold; the tremor is detected and recorded by seismographs only.
2	Hardly perceptible (very slight)	Felt only by people at rest. No effect on objects. No damage to buildings.
3	Weak	Felt indoors and outdoors by a few. Attentive observers notice a slight swinging of hanging objects, more heavily on upper floors. No damage to buildings.
4	Largely observed	Felt indoors and outdoors by many people. A few sleeping people are awakened. Windows, doors and dishes rattle. Floors and walls creak, furniture begins to shake. Hanging objects swing slightly, liquids in open vessels are slightly disturbed. No damage to buildings.
5	Fairly strong	Buildings tremble throughout. Felt by all the people. Many sleeping people awake. A few run outdoors. Animals become uneasy. Hanging objects swing considerably. Paintings swing out of place. Certain unstable objects may be overturned or shifted. Open doors and windows are thrust open and slam back again. Liquids spill from well-filled open containers. Slight damage to buildings.
6	Strong	Felt by all the people. Many people in buildings are frightened and run outdoors. A few people lose their balance. Dishes and glassware may break. Paintings fall down. Cracks in walls, plaster is coming off the wall, some roof tiles fall down, damage to masonry structures.
7	Very strong	Most people are frightened and run outdoors. Large and deep cracks in walls; chimneys collapse and some roofs are destroyed; landslips of roadways on steep slopes; seams of pipelines are damaged. Landslides.
8	Damaging	Furniture may be overturned. Some (parts of) buildings collapse. Landslides in hollows and on banked roads on steep slopes. Large cracks opening up, rockfalls.
9	Destructive	General panic. People are thrown to the ground. Substantial damage to well-built structures, underground pipelines are partly broken, railway lines are bent and roadways damaged. Rockfalls and widespread landslides.
10	Devastating	Partial or total collapse of buildings. Critical damage to dams. Railway lines are bent. Massive landslides.
11	Catastrophic	Most buildings and structures collapse. Ground fracturing and landslides.
12	Very catastrophic	All surface and underground structures completely destroyed. Landscape completely changed, rivers are deflected.

Source: <http://inforisx.incd.ro/>

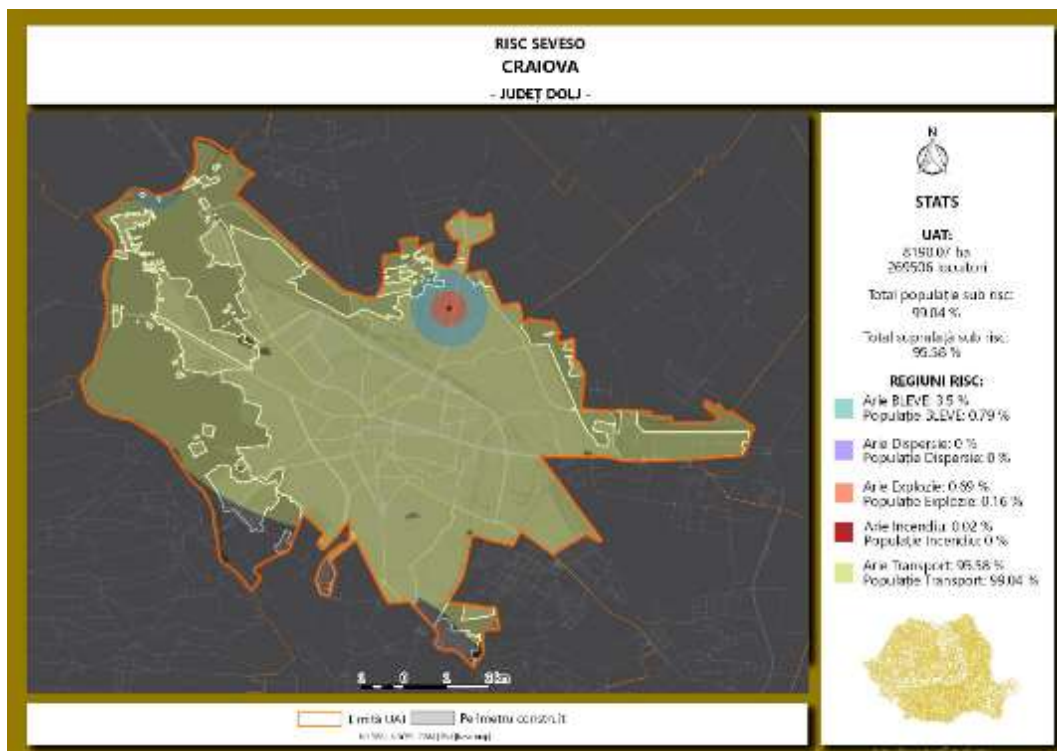
## Seveso hazard

The Seveso hazard refers to potential accidents in the chemical industry and was named after the EU Directive 82/501/EEC (Seveso Directive), adopted in 1982 following some accidents with a major environmental impact. In 1996, the Seveso Directive was replaced by Council Directive 96/82/EC (Seveso II Directive), which was subsequently amended by Directive 2003/105/EC. This Directive applies to several thousand industrial **establishments** where dangerous substances are present in quantities equal to or in excess of the thresholds specified in the Directive. This Directive is aimed at the prevention of major accidents which involve dangerous substances and the limitation of their consequences for man and the environment. The Seveso hazard is estimated by distinct categories (BLEVE - boiling liquid expanding vapor explosion; dispersion; explosion; fire; transport of dangerous goods). The institutions responsible for the implementation of the Seveso II Directive include:

- at national level: the Ministry of the Environment, Waters and Forests, the National Environmental Protection Agency, the General Inspectorate for Emergency Situations and the National Environmental Guard;
- at regional level: the Regional Environmental Protection Agencies and the Regional Commissariats of the National Environmental Guard;
- at local level: the Environmental Protection Agencies, the County Inspectorates for Emergency Situations and the County Commissariats of the National Environmental Guard

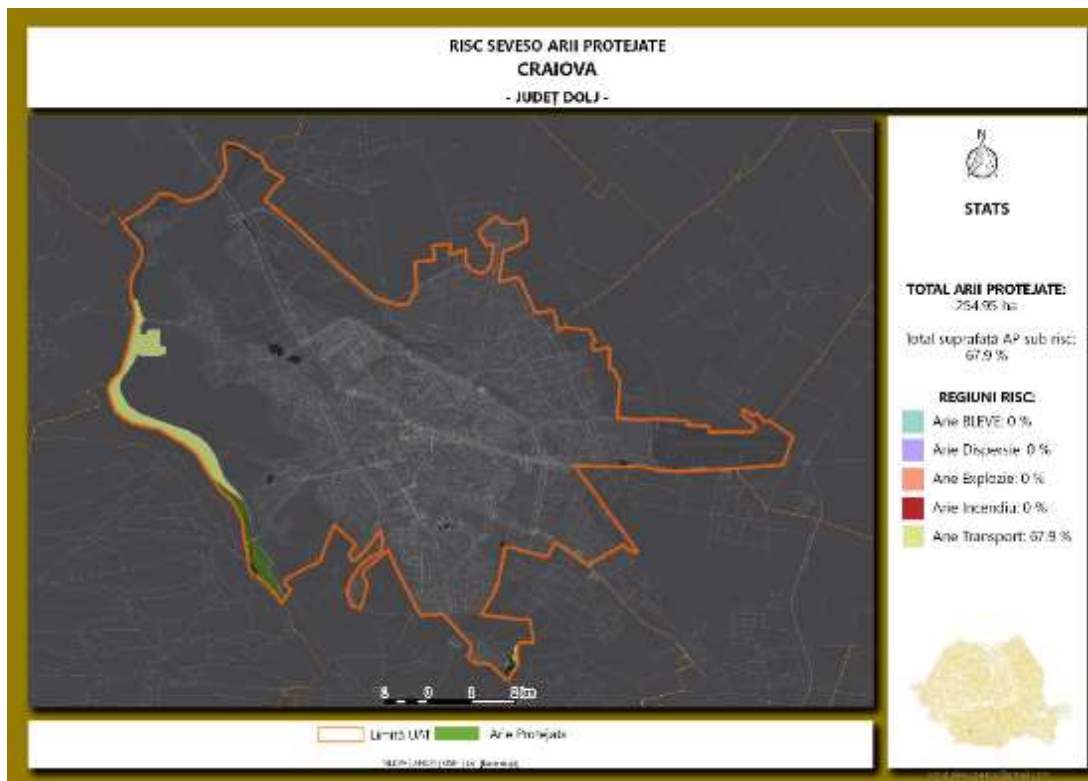
The maps below show the share of the population and the protected natural areas potentially affected by an accident with a major environmental impact. The Seveso hazard in Craiova is associated with the Craiova II Thermal Power Plant; a major accident happening at this entity would affect almost the entire population of Craiova and approx. 68 % of the protected areas in Craiova.

**Figure 46. Share of the population in Craiova exposed to a Seveso hazard**



Source: Romania's Urban Policy

Figure 47. Protected areas in Craiova exposed to a Seveso hazard



Source: Romania's Urban Policy

## DIAGNOSTIC ANALYSIS: CONCLUSIONS, CHALLENGES, TRENDS AND RECOMMENDATIONS

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### Characterization of natural capital

#### Challenges

- Limiting the reduction of green area areas by reducing constructions in these areas

#### Recommendations

- Completion of the local register of green spaces and its correlation with PUG

### Nature reserves and protected areas

#### Challenges

- Green infrastructure is relatively poorly developed at the metropolitan level.
- Overall, the people of Craiova are satisfied with the green spaces available in the city. The Urban 2020 Barometer developed within the Romanian Urban Policy, estimated the degree of satisfaction with green infrastructure in 41 cities in Romania. Craiova is among the cities with the highest degree of satisfaction, with 27% declaring themselves to be very satisfied and 45% satisfied.

#### Recommendations

- Development of a metropolitan green belt.
- The development, rehabilitation and maintenance of urban and urban infrastructure should be an absolute priority for every town hall in the country. Of the county residences in Romania, only 5 have more than 26 m<sup>2</sup> of green spaces per capita - the margin recommended by the European Commission for urban spaces. Craiova is one of these 5 county residences, with 26.5 m<sup>2</sup> of green spaces per capita, which means that it has a strong foundation on which to build.
- The degree of accessibility of green spaces is relatively good. Thus, about 67% of Craiova residents are less than 5 minutes from a green space, 23% are 10 minutes away, and 9% 20 minutes away. This is an area where improvements are possible. For example, 91% of Târgu-Mureș residents are 5 minutes away from a green space, and 85% of Cluj and Iasi residents, 78% of Timisoara residents, or 74% of Satu Mare, Sibiu or Brasov residents. In addition to expanding the classic infrastructure of green spaces (parks, squares), another measure that can increase the quality of life in the city is a program like "no street without greenery", which can introduce green infrastructure in every corner of the city.
- At the level of the Functional Urban Area (ZUF), the city of Filași has approximately 33 m<sup>2</sup> of green spaces per capita, and the city of Segarcea approximately 25 m<sup>2</sup> per capita. Obviously, the rehabilitation, modernization and development of green infrastructure in all localities in ZUF will be of interest and the development of a metropolitan green belt can be considered. According to SIDU Craiova 2024, ZUF Craiova has over 22,000 ha of forests and forest vegetation - a strategic natural resource that can contribute to increasing the quality of life in the area.

## Quality of environmental factors and pollution (water, air, soil)

### Challenges

- The main sources of pollution in Craiova are their production and transport activities.
- The World Bank has developed for the Ministry of Regional Development and Public Administration a "Guide to Investments in Water-Canal Infrastructure", which also mapped the quality of all water bodies in Romania, according to data from Apele Române. According to these data, the Jiu River has a moderate, poor or very poor water quality, throughout its length through Dolj County. However, many rivers that drain into Jiu are of good or very good quality. These rivers may have the potential to develop blue-green infrastructure.
- At the urban level, a factor that can affect water quality is the share of impermeable surfaces - ie surfaces that do not allow water to infiltrate the soil in a city. At national level, Craiova ranked 9th in terms of waterproof urban area, according to data for 2018 from the National Institute of Statistics.
- An analysis carried out by a team led by Cristian Iojă from the University of Bucharest, estimated the air quality in all cities in Romania, and Craiova is on the 4th place at national level, in terms of pollution. The people of Craiova are among the most dissatisfied with the air quality in their city.
- In 2015, the average value of the concentration of suspended particles in Craiova was about 30 ug / m<sup>3</sup>. On October 3, 2020, when this chapter was prepared, one of the air monitoring stations in Craiova recorded the value of 43 ug / m<sup>3</sup>. Another monitoring station in the city recorded a value of 0.33 ug / m<sup>3</sup>. The annual limit value to be reached starting with January 1, 2020 is 20 ug / m<sup>3</sup>. The annual limit value for the protection of human health is 40 ug / m<sup>3</sup>, and the daily limit value is 50 ug / m<sup>3</sup>.
- At the level of Craiova, the main source of pollution with sulfur dioxide is the Oltenia Energy Complex (CEO), with its two units - Işalniţa Thermal Power Plant and Craiova II Thermal Power Plant. In recent years, a number of major investments have been made by the CEO, mainly in flue gas desulphurisation plants. In 2015, the average annual concentration of sulfur dioxide in Craiova was about 17 ug / m<sup>3</sup>. On October 3, 2020, when this chapter was written, the average daily SO<sub>2</sub> concentration was 26 ug / m<sup>3</sup>. Values below the threshold of 125 ug / m<sup>3</sup> are considered to have little impact on human health.
- The high values for this indicator are found in urban ecosystems characterized by heavy traffic and / or the presence of industrial activities in which combustion processes are a characteristic component - Craiova being one of these urban ecosystems. The issue of values for nitrogen dioxide concentrations is related to exceedances in urban areas with large numbers of inhabitants, hence the potential to affect the health of the population to a considerable extent.
- Craiova is among the cities with the highest degree of pollution in terms of NO<sub>2</sub> concentration. The average annual value recorded in 2015 was approximately 34 ug / m<sup>3</sup>. On October 2, 2020, an average daily value of approximately 151 ug / m<sup>3</sup> was recorded at one of the air quality monitoring stations in Craiova. Concentrations above 140 ug / m<sup>3</sup> are considered to be harmful to human health.
- The people of Craiova, together with the people of Bucharest and Ploieşti, are among the most dissatisfied with their noise level in the city, with 42% declaring that they are dissatisfied, and 14% very dissatisfied .:
- Craiova, had in 2015 an average temperature 1.3°C higher than the average for 1960-2000. The latest data, for 2019, indicate an average temperature of 1.7°C above the average for 1960-2000. On the other hand, if we take the average for 2015-2019, it is 1.22°C above the average 1960-2000. If we look at the evolution of the average annual maximum temperature, we see that it is constantly increasing, at a worrying pace.
- The city of Craiova is part of an area with average changes in terms of rainfall.

- The city of Craiova has the highest thermal risk among the 263 cities in Romania, except for Bucharest, for which data were collected. Specifically, 87.5% of the population of Craiova is exposed to high or very high thermal risk. This reality obviously imposes the need for interventions (eg increasing green areas - parks, roofs, public areas) to help reduce the thermal risk.
- The main generators of greenhouse gases are the thermal power plants from Işalniţa and Craiova II, as well as the companies from the industrial platforms of the city. Car traffic is also an important and growing source.
- The potential of Craiova for wind exploitation for energy purposes is relatively low, due to the wind speed in the area, which is in an average band - 4-6 m / s.

#### Recommendations

- The environmental quality monitoring system in Romania is deficient. For example, the number of air pollution monitoring stations is insufficient, often poorly placed (industrial activities have moved out of cities), and in some cases non-functional. Other limitations of the environmental quality monitoring system include: the small number of indicators that can be monitored at an appropriate frequency; the difficulty of maintaining a unitary evaluation methodology at national level; reduced flexibility in network extension, where situations arise that require it.
- The reduction of impermeable spaces can have a positive impact not only on the quality of urban soil and water bodies, but can also contribute to reducing the effect of urban heat island, which affects Craiova in particular.
- At the level of Craiova there are 5 air monitoring stations. Given the rather high degree of pollution in Craiova, it would be worth considering the option of expanding and modernizing the air quality monitoring stations in the area.
- Modernization of Işalniţa and Thermal Power Plants with the help of generous European funds, both in the 2014-2020 and 2021-2027 programming period.
- Emergency development of new compliant garbage storage cells in the Mofleni landfill.
- Develop major road infrastructure to divert transit and heavy traffic out of town and encourage private investors to incorporate environmental considerations for new or existing facilities.
- Data collected by CESTRIN show that at national level, Craiova is on the 9th place in terms of the estimated daily number of cars transiting the locality. These data indicate the need to develop an urban belt to divert heavy and transit traffic outside the city, but also raise the issue of more ambitious investments in non-motorized transport infrastructure (pedestrian and bicycle) and public transport.

#### Climate change and environmental risks

##### Challenges

- The National Institute for Earth Physics has developed a seismic zoning map for Romania, where the areas most susceptible to an earthquake have been identified. Craiova is included in the intensity zone 6, although the 1977 earthquake had an impact that would place Craiova, rather in the risk class 9.
- The Seveso risk is associated with the Craiova II Thermal Power Plant and a potential major accident at this entity would have a negative impact on almost the entire population of Craiova and on approximately 68% of the protected areas in Craiova.
- Rising average annual temperature and the risk of desertification.
- A large share of the population is exposed to thermal risk.
- A low share of renewable energy use.

## Recommendations

- Even if there is no clear cyclicity of high-intensity earthquakes in Craiova, in the period 1700-2019, it is still important to prepare for an earthquake like the one in 1977. Particular attention must be paid to measures to reduce the negative impact of an earthquake. Of particular importance is the observance of clear standards and norms in construction, the identification and consolidation of vulnerable buildings (special priority should be given to educational infrastructure), the dissemination of earthquake response procedures and the development of rapid response systems.
- An ambitious campaign for afforestation of the Craiova Metropolitan Area (including a green belt), carried out together with the Dolj County Council and the other ATUs from ZMC.
- Ambitious program to green Craiova (eg "No street without greenery").
- Craiova can take advantage of the solar potential to generate energy and hot water.