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## Building heat resilience in Zagreb, Croatia

Embracing Nature-Based Solutions to cope with heat waves amid urbanisation and climate change

*Implementing green infrastructure<sup>1</sup> and nature-based solutions at local level in Zagreb is increasing the climate resilience of the whole city.*

### Key Learnings

**Green infrastructure/Nature-based solutions:** Heat is not equally distributed in urban areas, as the existence (or lack) of vegetation strongly affects local temperatures. Green infrastructure can contribute to cool the surrounding area by up to 4°C. There are several additional benefits for other sectors, including an improvement in air quality and the overall quality of life in the area.

**Multiple co-benefits:** While green infrastructure was mainly implemented to counteract urban heat, it can also deliver multiple co-benefits (e.g., health, social, economic and environmental). For example, green roofs can provide insulation, manage stormwater, and offer recreational spaces, maximises their value and efficiency.

**Planning and implementation at local level:** The local circumstances that provide the impetus to implement green infrastructures are very different, even within one city. Solutions need to be tailored to circumstances at the district level. Involving a broad range of relevant stakeholders contributes to finding the most effective solution and enables successful implementation.

<sup>1</sup> Green infrastructure can be defined as “A strategically planned network of natural and semi-natural areas with other environmental features, designed and managed to deliver a wide range of ecosystem services, while also enhancing biodiversity.” (see [https://environment.ec.europa.eu/topics/nature-and-biodiversity/green-infrastructure\\_en](https://environment.ec.europa.eu/topics/nature-and-biodiversity/green-infrastructure_en))

### About the region

Zagreb is the capital, and the economic and cultural centre, of Croatia and has around 800.000 inhabitants. It is located in the North-West of Croatia between the Medvednica mountain in the North and the Sava river in the South. Due to the combined effects of urbanisation and climate change, the region increasingly faces hot summers with average temperatures in July above 22°C.

### Climate Hazards

Extreme temperatures

#### Sector

Urban

#### Key system

Infrastructure

Health and Wellbeing

Ecosystem and Nature-based solutions



### Climate threats

Urbanisation and climate change are increasingly leading to hot summers in Zagreb. Over the past decades, the climate classification of the region has changed from a "humid moderate **warm** climate with warm summers" to a "humid moderate climate with **hot** summers". Due to climate change, the frequency and intensity of heat waves have increased. During heat waves, air temperatures in urban areas are considerably higher than in the surrounding suburban and rural areas. This so-called Urban Heat Island effect can account for up to 3-5°C temperature increase. Therefore, the local temperature results from the combined effects of global climate change and local factors such as urbanisation. Moreover, heat stress is not distributed equally across the urban area, i.e., some areas are more affected than others. Without further action, heat stress is projected to intensify in the future. Heat impacts all sectors, but primarily the health and well-being of the inhabitants.

*"Extreme weather events will be more frequent in the future as climate is changing. Zagreb has to adapt its processes and infrastructure!"  
Tomislav Tomašević, Mayor of the city of Zagreb*

### Variations in heat distribution

When a major earthquake hit the city of Zagreb in 2020, the process of rebuilding was seen as an opportunity to address increasing heat stress more comprehensively. As a first step, a heat map for one city district was developed, and the impacts of heat on different sectors were analysed. The spatial distribution of heat showed significant temperature variations of up to 4°C in a same building block, which were primarily determined by the existence or non existence of green infrastructure. In general, areas rich in green infrastructure were cooler than those without.

The image below shows the temperature variations across different areas of Zagreb's city centre during the summer months of 2020. It provides a comprehensive visual representation of the urban landscape. Notably, it shows the significant temperature contrast between four distinct city centre areas. Park Zrinjevac, a section of the city centre with a lush tree canopy and a vibrant park, stands out as surface temperatures are considerably lower in this green, shaded area compared to the surrounding urban environment. This highlights the cooling effect of green spaces in cities and offers valuable insights into the possibilities of counteracting urban heat.

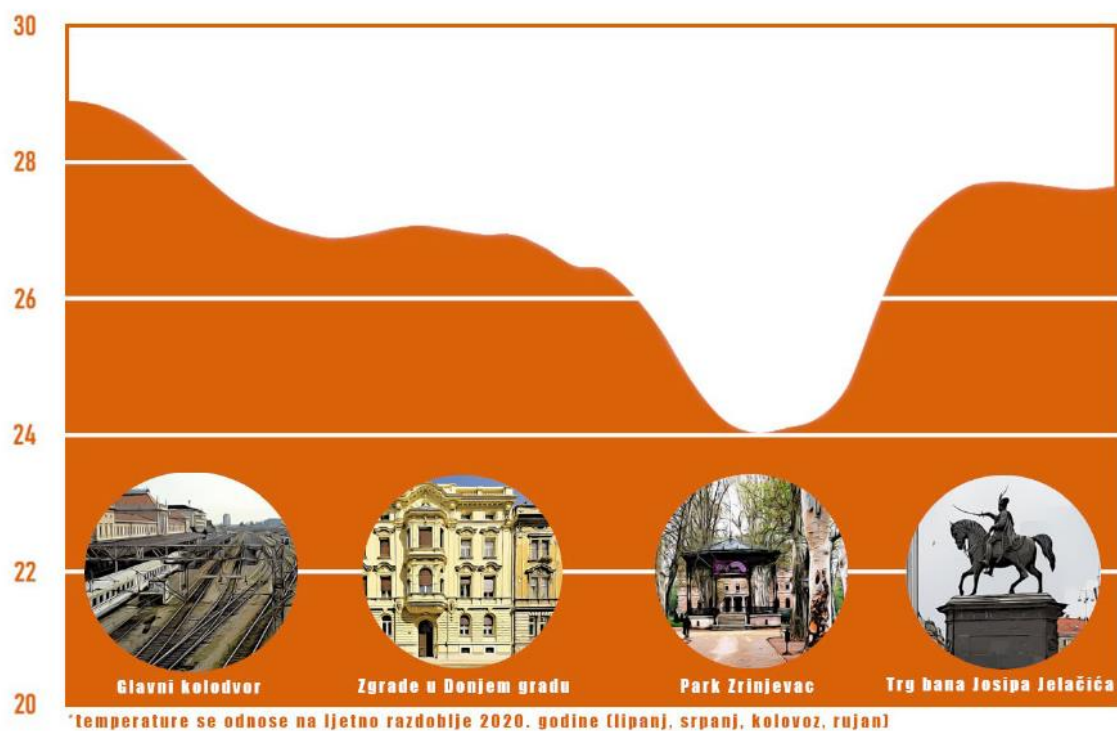


Figure 1 Surface temperatures (°C) in four distinct city centre areas in Zagreb during the summer period (June to September) 2020.

Based on initial analysis, a set of nature-based solutions was suggested with the objective of inducing a cooling effect. To plan adaptation measures holistically and avoid maladaptation, a more comprehensive heat assessment on the level of the whole city was carried out in cooperation with the University of Zagreb (Department for Geophysics).

### Implementing green solutions

Based on the analysis of urban heat distribution at the block level, green infrastructure and nature-based solutions were included in the rebuilding process. A detailed analysis of a pilot block revealed the benefits for different sectors such as health, transport, and energy. For example, green spaces also have a social impact as they increase the quality of life and stimulate socialising. Positive effects on health include the improvement of air quality and the mitigation of health risks for vulnerable groups. These multiple benefits were considered when planning the solutions. The graphic below shows the proposed green infrastructures and nature-based solutions in the pilot block.

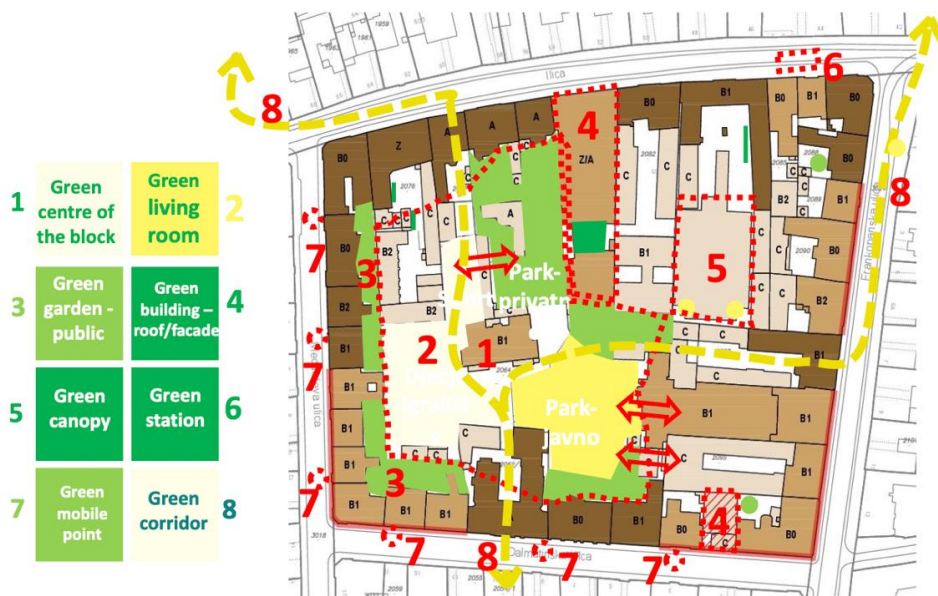


Figure 2 Sketch of the proposed green infrastructures and nature-based solutions on the block level. Copyright: Miljenko Sedlar (REGEA)

Focusing climate change adaptation at district level makes it easier to find appropriate solutions that fit the local circumstances, which can then be integrated into a wider context. The involvement of a broad range of stakeholders - city administration, the office for spatial planning, citizens in the block, Non-governmental Organisations and academia - is crucial to finding the best possible solution.

The rebuilding of the city after the earthquake provided an opportunity for the comprehensive study of heat stress and the subsequent implementation of green infrastructure and nature-based solutions in city blocks. Ongoing pilot projects, like Greening the City (which involves the architectural design and planting of 1500 trees throughout the city, especially at educational facilities) and GreenscapeCE2 (a project which aims to develop technical and financial prerequisites for the deployment of green infrastructures and nature-based solutions) also provided solutions.

*"One of the primary objectives of Zagreb's city administration is the greening of the city. We are committed to significantly expanding urban green spaces, particularly emphasising the prospects for greening within our city blocks."  
Luka Korlaet, Deputy Mayor of the city Zagreb*

<sup>2</sup> <https://www.interreg-central.eu/projects/greenscape-ce/>





Figure 3 Aerial picture of the block in the city of Zagreb where the nature-based solutions will be implemented.

## Summary

The example of Zagreb demonstrates that implementing nature-based solutions offers a promising response to increasing heat in cities due to climate change and urbanisation processes, helping move towards climate resilient cities. Such green structures contribute to the cooling of city blocks by several degrees and offer a broad range of co-benefits to cities plagued by heat stress. In planning nature-based solutions, it is essential to involve all relevant stakeholders to fit the adaptation measure to the local circumstances and the wider context.

## Further information

- Heat Stress of the City of Zagreb (Faculty of Science, Department of Geophysics) available at [https://www.pmf.unizg.hr/geof/en/research/climatology/croclimgogreen/about\\_the\\_project](https://www.pmf.unizg.hr/geof/en/research/climatology/croclimgogreen/about_the_project)
- FAQ 10.2 | Why Are Cities Hotspots of Global Warming? (IPCC Sixth Assessment Report, Working Group I) available at <https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-10/>

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