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DETERMINING TERRITORIAL SCOPE ACCORDING TO POTENTIAL CLIMATE CHANGE EFFECTS

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Justification for Selecting City Municipality of Medijana as the Spatial Focus of Climate Change Research

The City Municipality of Medijana, serving as the urban core of the City of Niš, exhibits a distinct and intensifying pattern of climate change indicators, making it a compelling case for focused spatial research. Key climatic observations and future projections (see “Analysis of Observed and Expected Climate Changes in the Territory of the City Municipality of Medijana”) underscore Medijana’s heightened vulnerability and the need for targeted adaptation strategies.

Observed Climate trends

Between 2001 and 2020, Medijana experienced a notable increase in average ground-level temperature by **1.40°C**, with the rise accelerating to **1.80°C** in the last decade (2011–2020), compared to the baseline period 1961–1990. This warming is particularly pronounced in **maximum summer temperatures**, indicating intensifying heat stress.

The frequency and intensity of **heatwaves and extremely hot days (above 35°C)** have surged, with such events now occurring **four times more frequently** than in the reference period. Concurrently, **cold extremes** (e.g., frost and ice days) have declined, contributing to a shift toward a predominantly warm climate regime.

The **Urban Heat Island (UHI) effect** further amplifies these trends. As the most densely populated and built-up district of Niš, Medijana exhibits stronger warming compared to its suburban and rural surroundings. This reinforces the microclimatic disparities typical of urban centers and increases the risk of heat-related health issues and energy demand.

Changing Precipitation Dynamics

While total annual precipitation has shown only moderate variation (+8–10%), its **seasonal distribution and intensity** have shifted significantly. Rainfall is now increasingly concentrated in **fewer, more intense events**, which elevates the **risk of urban flash flooding**. At the same time, prolonged **dry spells**—although interspersed with fewer consecutive dry days—are becoming more frequent, complicating water resource planning and increasing drought risk.

Climate Projections and Risks

Future scenarios highlight escalating risks. Under **RCP4.5**, average temperatures could rise by **2.05°C** by 2100, while under the more extreme **RCP8.5**, increases may reach **4.12°C**, with maximum summer temperatures exceeding **5°C**. Days exceeding 35°C may increase to **27 or more per year**, while **heatwave frequency** could reach **seven events annually**, with durations surpassing **70 days**.

In parallel, **drought frequency** is projected to intensify, with **almost every year between 2091 and 2100** potentially experiencing drought conditions under RCP8.5. Seasonal reductions in precipitation, especially in **summer and winter**, are expected to further threaten **water availability, agricultural stability, and ecosystem resilience**.

Urban-Specific Impacts

The City of Niš is the largest urban center in the South and East Serbia region (NUTS 2), one of five statistical-territorial units in the Republic of Serbia. Since 2004, it has been administratively divided into five city municipalities: Medijana, Niška Banja, Palilula, Pantelej, and Crveni Krst. The City comprises the urban settlements of Niš and Niška Banja, along with 69 surrounding villages.



Figure 1. The Position of the City Municipality of Medijana within the Republic of Serbia and the Nišava Administrative District



Figure 2. City Municipality of Medijana – boundaries and built-up area

The City Municipality of Medijana encompasses only the central part of the urban settlement of Niš, while the remaining parts of the city, including Niška Banja and the rural areas, fall under the jurisdiction of the other four municipalities. Although Medijana is the smallest in terms of land area—covering just 10 km²—it is the most populous, with 83,275 residents, and the most densely populated, with 8,328 inhabitants per square kilometer.

The post-socialist transition brought significant changes to the urban landscape of Niš, particularly in terms of its physical structure and functional organization. It triggered processes such as deindustrialization, suburban sprawl, informal expansion of construction zones, illegal building activity, densification of both the city center and older multi-family housing areas, traffic congestion, and a decline in public and green spaces. These trends have raised urgent environmental concerns, including the city's growing ecological footprint, air and noise pollution, inadequate stormwater management, and the intensification of urban heat island (UHI) effects.

In parallel with these spatial and environmental transformations, demographic shifts have also shaped the city's development trajectory. Population movements, including rural-to-urban migration and suburbanization trends, have contributed to the uneven distribution of residents and services. This has placed growing pressure on urban infrastructure, especially in Medijana, where high population density intensifies demands on transportation, water supply, waste management, and energy systems.

The degradation of public and green spaces has been especially evident in central areas, where infill development and the repurposing of formerly communal land for private use have limited residents' access to recreation and negatively impacted overall urban livability. Meanwhile, the uncontrolled expansion of low-density housing at the periphery has increased reliance on private transport, exacerbating traffic congestion and air pollution.

In terms of governance, the decentralization of city administration into five municipalities has not always been matched with the financial and technical capacity required to manage complex urban challenges. Institutional coordination across municipal boundaries remains limited, hampering integrated planning and the implementation of city-wide policies, particularly those related to environmental protection, climate adaptation, and sustainable land use.

The urban setting of Medijana amplifies the exposure and sensitivity of populations, infrastructure, and services to climate risks. Implications span across multiple sectors:

- **Public health**, due to increased heat-related illnesses;
- **Infrastructure**, strained by heat extremes and flooding;
- **Energy systems**, facing surges in cooling demand;
- **Water management**, challenged by dual risks of flooding and drought;
- **Biodiversity and green spaces**, under pressure from thermal and hydrological stressors.

Given the convergence of observed impacts, projected trends, and urban-specific vulnerabilities, **Medijana represents a critical zone for in-depth climate impact research and resilience planning**. Its selection as the spatial focus allows for the development of localized adaptation strategies that could serve as models for other urbanized areas facing similar challenges across Southeast Europe.

Potential Indicators

Exposure

- Built-up ratio (or) Building coverage ratio (BCR)
- Floor area ratio (FAR) (floor space index – FSI) (average)
- Street canyon aspect ratio
- Sky view factor
- Surface albedo
- Artificial impervious cover ratio (Share of sealed surfaces compared to total urban space; Share of permeable surfaces related to impermeable surfaces)

Sensitivity

- Population density
- Rate of inhabitants living in substandard settlements
- Ratio of old and very old population
- Ratio of children up to 6 years old
- Anthropogenic heat flux index
- Land use
- Green area / urban area ratio
- Tree canopy coverage
- At risk of poverty threshold
- Number of inhabitants per public health unit
- Presence of a heat-health early warning system
- Share of urban land endangered by erosion processes

Climate hazards

- Number of days with a maximum temperature above 35°C
- Number of tropical nights (where the minimum daily temperature is above 20°C)
- Daily rainfall rate (mm) / Annual average precipitation level (mm)
- Number of torrential floods
- Frequency and intensity of droughts

Adaptive capacity

- Legislative and regulatory regimes
- Local climate change policies and plans
- Percentage of physical entities and objects insured from natural disasters
- Financial capacities of municipality in relation to maintenance costs
- Level of investment in local infrastructure
- the number of health institutions
- The number of beds in hospitals per 1000 inhabitants