



Air temperature regulation by urban trees and green infrastructure  
UCLIMESA – Urban Heat Island Monitoring under Present and Future Climate  
by the Romanian Spatial Agency

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## The Intergovernmental Panel on Climate Change (IPCC):

- the impact of urban heat islands on temperature records is "real but local," and has only a negligible effect on regional or global trends.
- urban heat island effects on local climate appear to include changes in precipitation, clouds, and daily temperature range.

## *Urban Heat Island*

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### **In general:**

- UHI exists in large urban environments;
- As the climate and land-use change, UHI magnitude is presumed to increase;
- There are negative ecological, economical and social consequences.

### **In Bucharest:**

- Largest urban area in Romania;
- High density of built space and population (228 km<sup>2</sup>, over 2 mil. inhabitants);
- Green areas under pressure to be developed into other land uses;
- Built space with thermal insulation deficiencies;
- Many local plant species adapting difficultly to change in temperature, invasive species more resilient.

## *What are the causes of UHI in Bucharest?*

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- Expansion of urban built areas and supporting infrastructures, starting from already poor situation;
- **Low density of green areas (7.46 % compact green areas);**
- Low evapotranspiration;
- High heat conductivity and capacity of artificial cover (build space, roads);



- Increase in radiation absorbed (short-wave);
- Decrease of long-wave radiation loss;

## *What are the effects of Bucharest's UHI?*

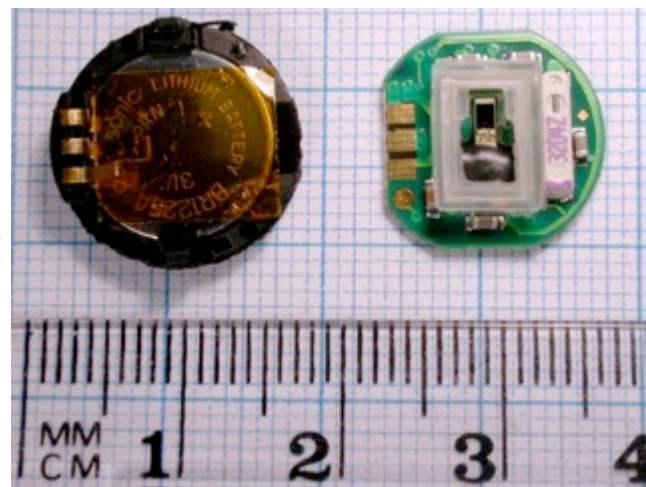
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- Expensive environmental costs for population and local administration;
- Need of better thermal insulation;
- Higher energy consumption for active cooling during the summer;
- Poorer air quality (more airborne PM for example);
- Damage to the green areas (tree dry outs, need of supplemental irrigation);
- Lower life quality;

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- UHI in Bucharest was analyzed through a network of sensors located in 56 points (47 inside the administrative boundary of the city, 9 outside) 2009-2011
  - The network lost progressively its initial density, but was reformed during a new phase, 2013-2015

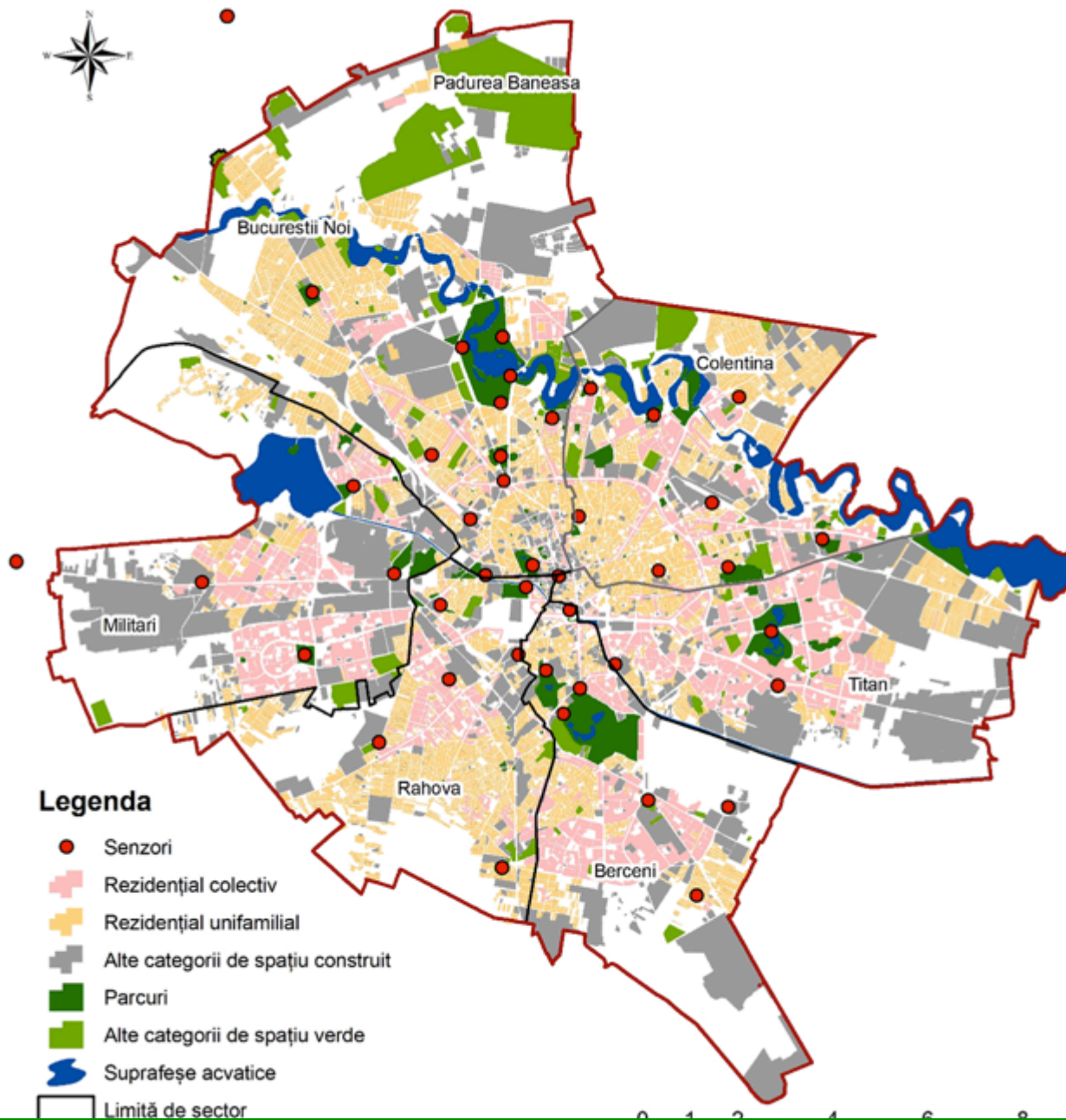
## DS1921G THERMOCHRON IBUTTON data logger monitors

- Hour interval recordings;
- Recording temperature and humidity;
- Monitoring between  $-20^{\circ}\text{C}$  and  $85^{\circ}\text{C}$ , accuracy  $\pm 0.5^{\circ}\text{C}$
- Storage capacity 8192 recordings
- Protection gainst particles, humidity and contaminats
- Placed in shaded locations, at least 5 meters from buildings, 1.5-2 meters high





## Distribution of monitoring points

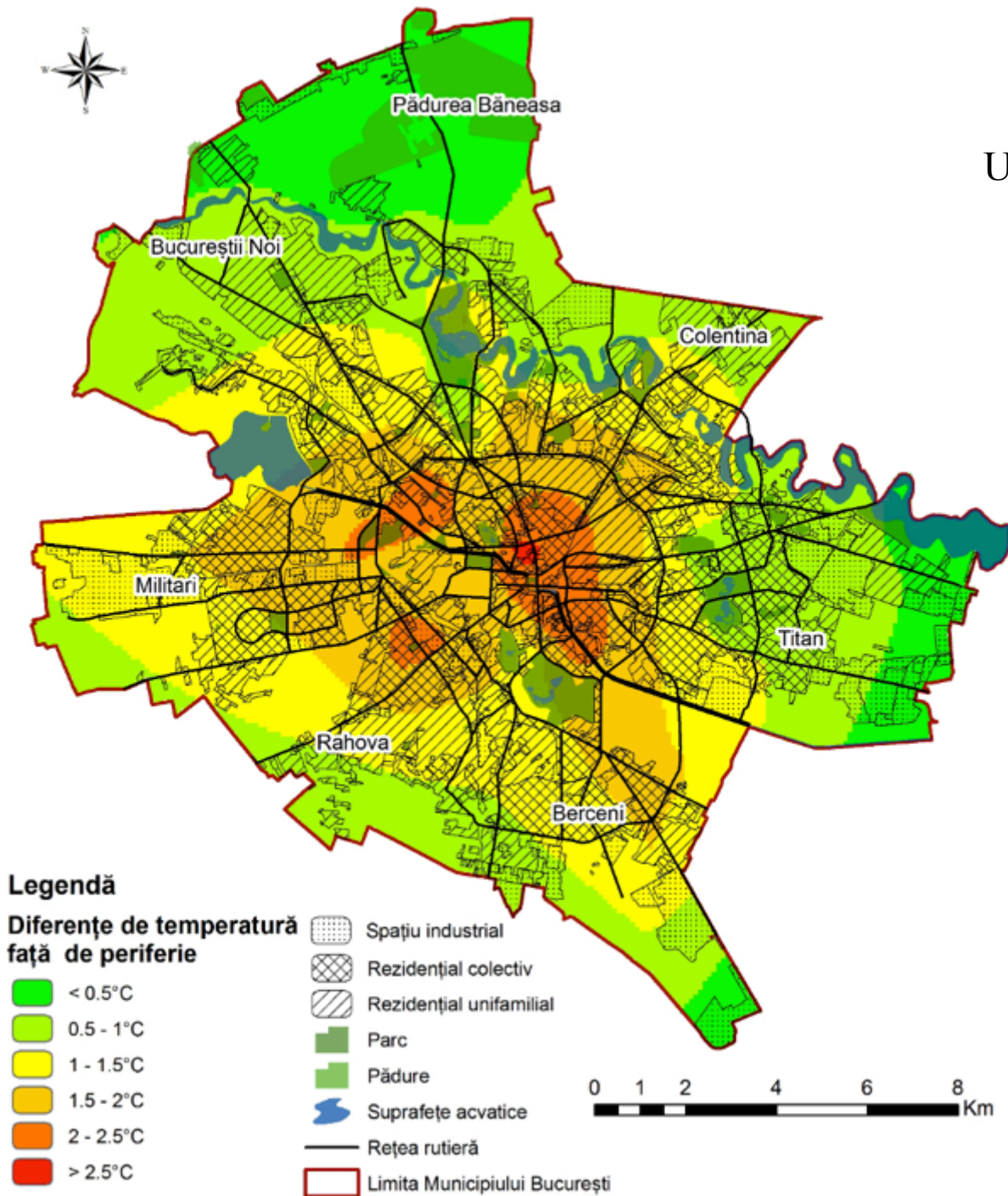


## *Data gathering difficulties*

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- Difficulties in collecting data from highly circulated spots – public parks etc);
- Loss of sensors by theft, tree trimming;
- Data discontinuity until the lost sensors are replaced;
- Placed in improper positions (direct sun exposure for example);

Dec. 2012 - Feb. 2013  
UHI in Bucharest in relation to  
functional areas



## *What we have found about UHI in Bucharest?*

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Expansion of the UHI outside the city center;

Boulevards flanked on both sides by a continuous front of high buildings register even higher temperatures;

Center – periphery differences can reach 3°C, compared with 1-2°C, as previous studies have shown;

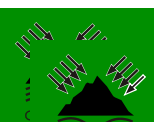
## *What are the main factors mitigating the UHI?*

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- Presence of large green areas;
- Presence of water bodies;
  
- Other measures that contribute are important, but less effective:
  - green walls, roofs;
  - better insulating materials;
  - traditional building materials;
  - adequate orientation of buildings;
  - natural ventilation.

## *Herăstrău Park (North part of the city)*

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- Largest in Bucharest 110 ha land, 74 ha water;
  - Declared and used as a park since 1936;
  - Bordering is the Village Museum (Swedish museum Skansen was the model) 12.5 ha;







## Herăstrău Park 15 September 2009

### Legend

● iButton

### Temperature (°C)

#### Value

High : 15.7004

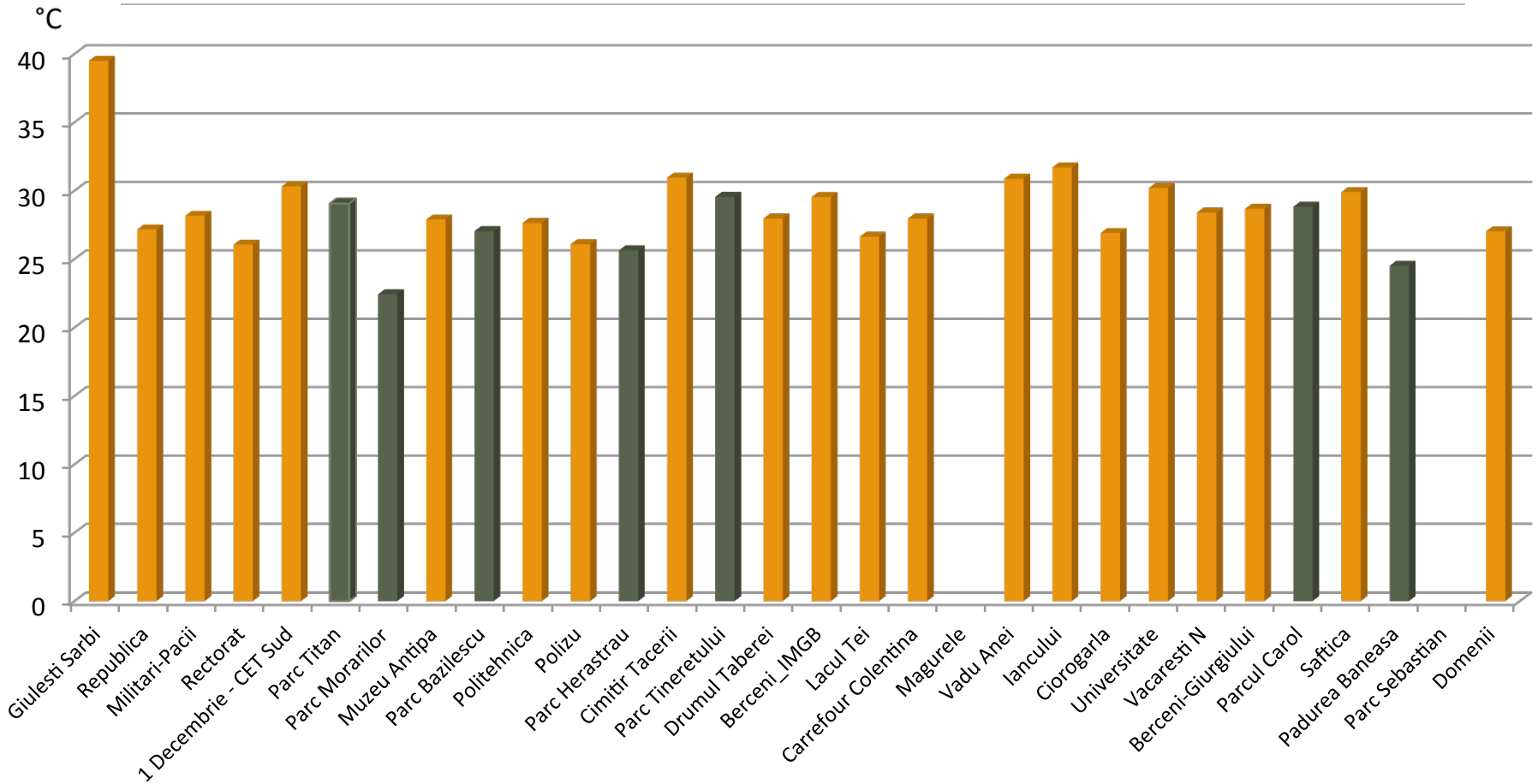
Low : 12.763

□ Park

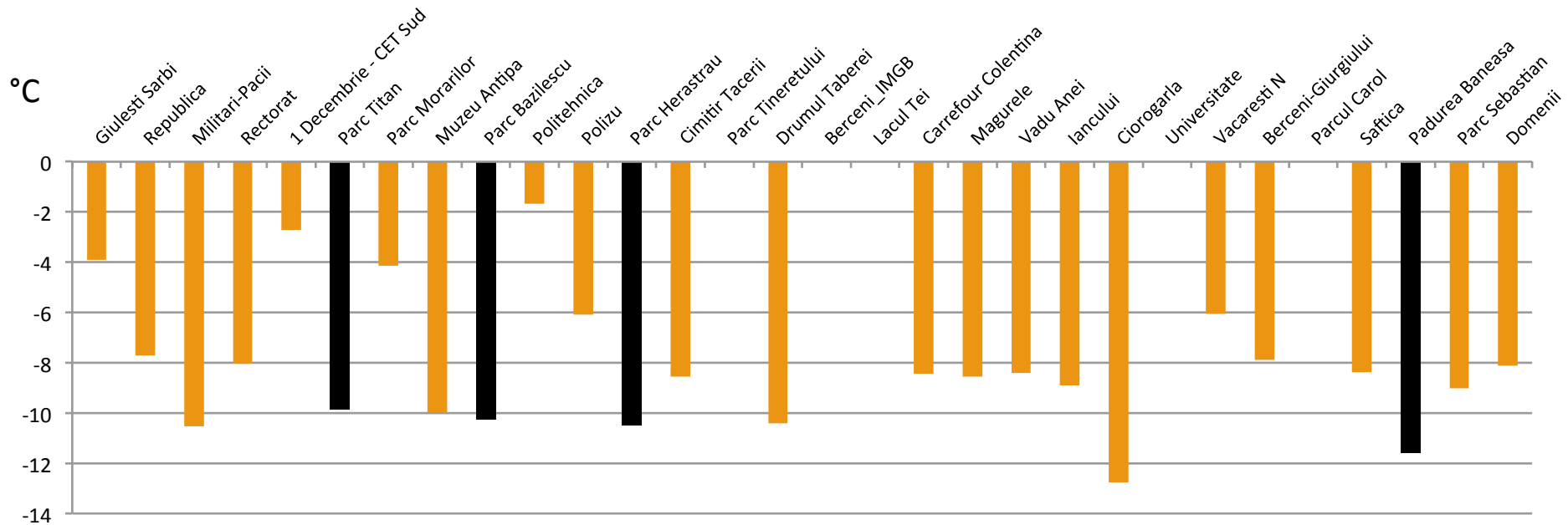
□ Water body

□ Built-up surface

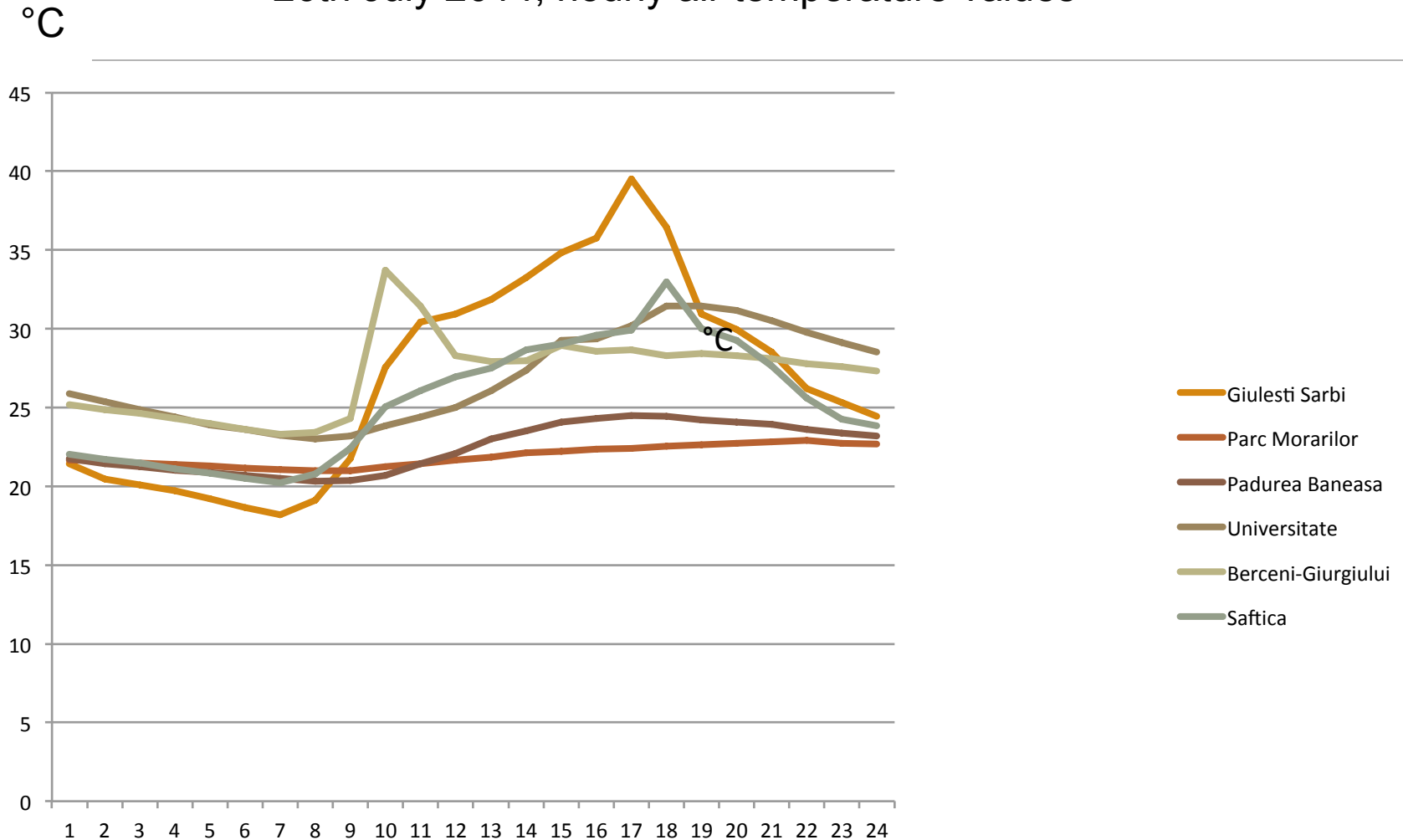
## 26th July 2014, daily average



## 1<sup>st</sup> January 2015, daily average



## 26th July 2014, hourly air temperature values



# Conclusions

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- local conditions extremely important for air temperature values in urban environments;
- differences in air temperature at Bucharest city scale sometimes reach 3-5 °C (both in the summer and in the winter);
- green areas and infrastructure provide temperature moderating benefits in summers for the immediate areas;
- UHI shows on maps and its position appears to be correlated with larger parks presence;
- while differences in air temperature between higher tree density areas and isolated trees can reach much higher values, averages over 24 h periods still are in the 3-5 °C range



Helmut Ignat





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**THANK YOU FOR YOUR ATTENTION!**

This work was supported by the Romanian Spatial Agency through the programme  
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