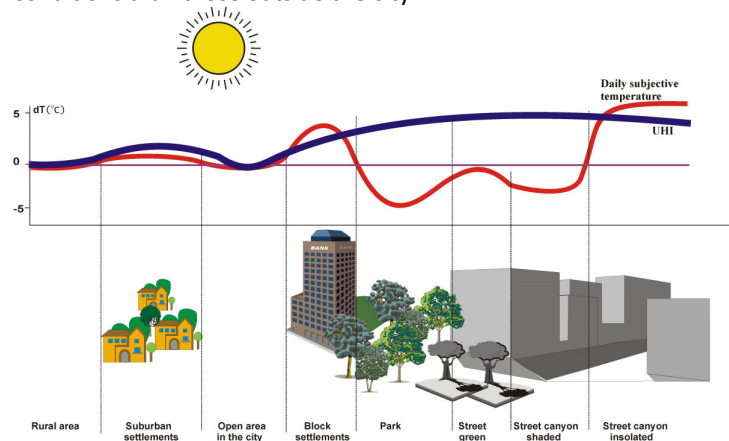


Based on the results of scientific research the model of **UHI** and the distribution of subjective temperature in the city was created. **UHI** occurs wherever there is urbanized area (even in city parks surrounded by buildings). During the day the diversity of subjective temperature is very high. High values of  $t_{sub}$  can be observed in street canyons in direct sunlight. Parks and even shaded street canyons are characterized by milder biothermal conditions than those outside the city.



*Urban heat island and subjective temperature in different part of the city.*

### Project UHI:

**UHI** is an international project carried out in the framework of the EU Central Europe Programme, dedicated to deepening regional cooperation in Central Europe. The aim of the project is to study **UHI** in selected cities in the region. The project also aims at developing mitigation and risk prevention and management strategies concerning the urban heat island phenomenon. A special monitoring systems of **UHI** in studied cities will be organized. The results will help to improve methods of land use designing and urban growth management.

The project includes 8 metropolitan areas: Bologna-Modena, Budapest, Ljubljana, Lodz, Warsaw, Prague, Stuttgart, Venice-Padua, Vienna.

Research of **UHI** in Warsaw Agglomeration is conducted by the Institute of Geography and Spatial Organization.

**Acronym:** UHI

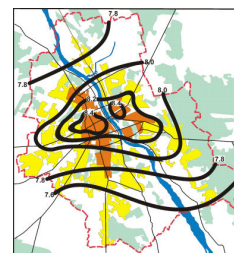
**Full name of the project:** *Development and application of mitigation and adaptation strategies and measures for counteracting the global Urban Heat Islands phenomenon (UHI)*

**Duration:** 2011-2014

**Website:** [www.eu-uhi.eu](http://www.eu-uhi.eu)

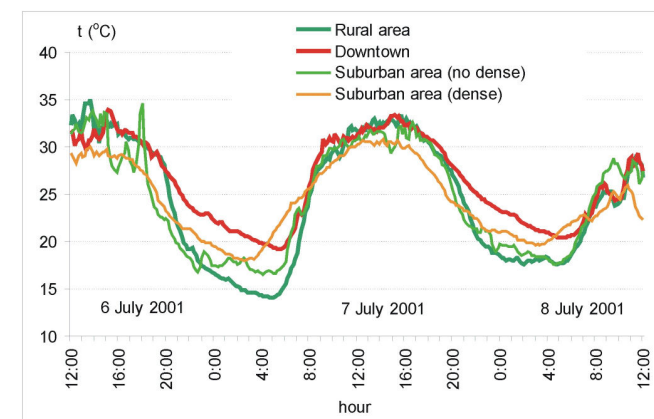


## Urban Heat Island in Warsaw



Urban heat island (**UHI**) is microclimatic phenomenon that occurs in urbanised areas. It consists in a significant increase of air temperature in urban area in relation to the surrounding peri-urban and rural neighbourhoods.

**UHI** is most intensive in the evening, night and early morning, when the air temperature in the city is even a few degrees centigrade higher than outside the city. During the day **UHI** loses its intensity and sometimes even disappear.



*Daily course of air temperature on some types of land use in Warsaw, July 6-8, 2001.*

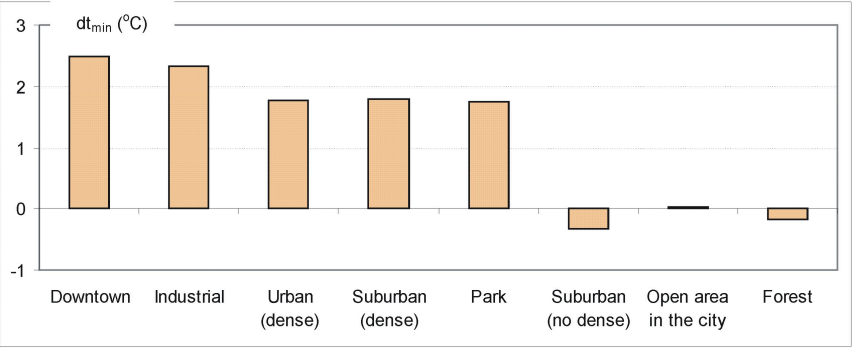
### UHI is effect of:

- physical characteristics of the surfaces: materials composing urban surfaces, such as concrete and asphalt, absorb rather than reflecting solar radiation
- lack of natural evaporative surfaces (vegetation) that, in rural areas, contribute to maintain a stable energy balance
- augmentation of the vertical surface that both provide an increased surface absorbing and reflecting solar radiation as well as block winds that contribute to the lowering of the temperature (canyon effect)
- human activities that mainly consists in heat produced by heating and cooling plants, industrial activities, vehicles, etc.

Therefore during the day large quantities of heat accumulate in the city. At night heat is gradually released into the atmosphere, making it warmer than outside the city.

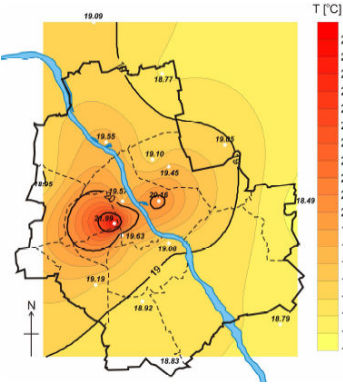
A measure of **UHI** is a difference of the minimum air temperature between urban and rural areas ( $dt_{min}$ ).

In Warsaw Agglomeration the differences in particular days can be up to 10-12°C. Medium, long-term values of  $dt_{min}$  in dense urban or industrial areas can reach 2,5°C. However, warming effect in the city may not be observed on open areas inside the city, in residential suburban estates with no-dense settlements as well as inside the forest.

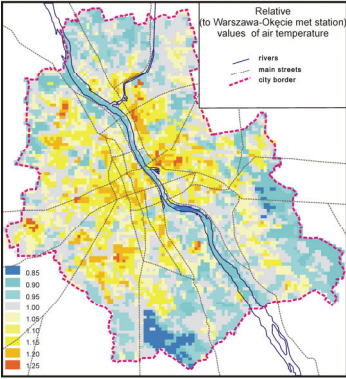


Average differences of the minimum air temperature ( $dt_{min}$ ) between some types of land use in Warsaw Agglomeration and rural area.

**UHI** in Warsaw occurs not as a single compact area, but as several separate spots of heat localized in dense urban and industrial areas.



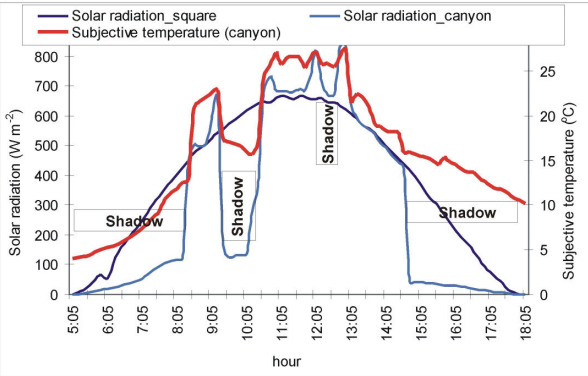
Average monthly air temperature in August 2007



Relative values of air temperature (data obtained from LANDSAT, July 2002)

### Impact of UHI on human well being:

For the residents of the city important issue is to recognize how does the **UHI** affect on human body. Bio-thermal conditions, by which we understand temperature, solar radiation and wind, are modified by the city and interact with human body. These conditions determine thermal sensations, which measure can be so-called subjective temperature ( $t_{sub}$ ).

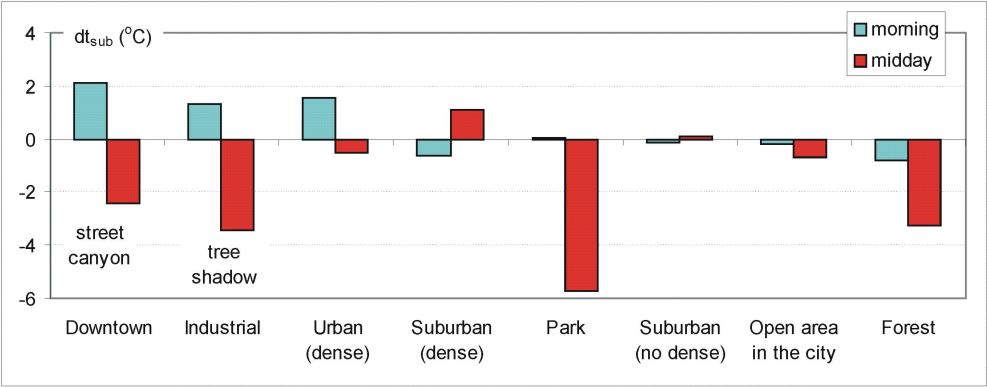


Subjective temperature in the bottom of street canyon on a sunny day in autumn; when bottom of the canyon stays in the shade there is a clear drop of subjective temperature.



Warming effect of **UHI** on the biothermal conditions can be clearly observed in the mornings. The biggest positive deviations of subjective temperature are present in dense urban districts and in Downtown as well as in industrial area of Żerań. Negative variations occur among the no-dense built-up suburbs and inside the forests.

During the day the variations of subjective temperature depend on whether a part of the city is shaded by buildings or trees. The negative deviation of maximum  $t_{sub}$  are observed both, under the canopy of trees (Park, Forest, Industrial area) and in street canyons.  $t_{sub}$  in parts of the city with direct sunlight may be higher as much as 5-20°C than outside the city.



Differences of sensitive temperature in the morning and in the afternoon in some types of land use in Warsaw Agglomeration.