Study of the heat island effect, in the coastal town of Patras

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ABSTRACT

In this work, the heat island effect is studied for the coastal town of Patras. For this purpose, a set of 13 data loggers, have been placed, in chosen representative locations, to monitor ambient air temperature variations. Collected data are presented for characteristic places. Results are extracted which indicate that heat island effects are much less intense in comparison with other inland towns.

1. INTRODUCTION

The continuously increased worldwide urbanization has created a series of problems, the most serious been the traffic difficulties, the climatic quality and the increased energy consumption. Ambient air temperatures in dense urban areas are higher than those of the surrounding rural country, a phenomenon known as “heat island”. It is clear that urban areas without a high climatic quality use more energy for air conditioning in summer and even more electricity for lighting. Moreover, discomfort and inconvenience to the urban population due to high temperatures, wind tunnel effects in streets and unusual wind turbulence due to wrongly designed high rise buildings is very common (Bitan, 1992). Statistical data (Stanners and Bourdeau, 1995) show that the amount of energy consumed by cities for heating and cooling of offices and residential buildings in western and southern Europe has increased significantly in the last two decades. An increase of the urban population by 1% increases the energy consumption by 2.2%, (Santamouris, 2001) i.e. the rate of change in energy use is twice the rate of change in urbanization.

Many works have carried out to investigate the impact of the urban climate on the energy consumption and living quality. A number of big, medium and small cities have been studied, each one having its own characteristics. In Greece, the case of Athens has been extensively examined (Santamouris et al., 2001; Martilli, et al., 2003). It would be very useful to examine the case of a medium size city, especially of an extended coastal city, in order to investigate possible particularities and/or similarities. For this reason, a measuring network is established for the study of the climate impacts in the city of Patras. A number of 13 automatic temperature measuring stations have been installed in the major Patras area. Collected data, for a period of 2 years, were analyzed and presented here, for representative locations.

2. DESCRIPTION OF THE URBAN REGION AND MEASURING NETWORK

The city of Patras is located in Southwest of Greece (38° 15′ N, 21° 45′ E, Fig. 1) and is the

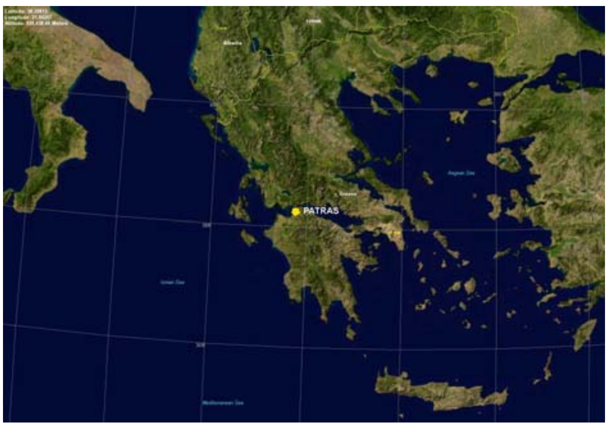

Figure 1: Patras location.

capital of this region. It has a population of about 200.000 people and expands across the sea and a few hills. It has a mild and moderate Mediterranean climate, with elevated precipitation.

Patras is not an industrial town. Its industrial zone is located much far away from the town and isolated by mountains. The center of the town is characterized by high automobile traffic.

In order to have a good figure of the climate impacts, a set of 13 temperature measuring stations have been installed in the major Patras area. The measurement places were selected with the following criteria:

I To get information about the boundary conditions around the town.
II To study densely built areas with heavy traffic.
III To study densely built areas with less traffic.
IV To study medium density built areas.

A detailed view of the major city area is given in Figure 2.

Five stations have been placed in densely built areas (urban) with heavy traffic; four stations have been placed in densely built areas (urban) with less traffic; two stations are placed in medium density built areas (suburban) and two stations are placed in rural areas. All the stations have been placed at the level of first floors, taking care, as much as possible, to be shaded and not affected by IR radiation. The instrumentation used was selected to satisfy several criteria like acceptable cost, satisfactory performance according to the international meteorological standards, low maintenance, inter-

Figure 2: Patras main view.

Figure 3: Measuring station.

nal power supply and high data storage capacity. In order to protect the instruments from solar radiation and rain, white wooden boxes with lateral slots were constructed, as shown in Figure 3. All sensors were calibrated between them and against high precision thermometers.

Measurements have been taken on a minute basis and stored every 1 hour.

3. RESULTS & COMPARISONS

The collected data have been treated and temperature variations are extracted. Two representative cases are selected and presented for the summer period of 2005 (1/6/05-30/8/05). The first case concerns comparisons between transversal and longitudinal to the sea streets, of the town center. As second case, comparisons between urban and rural areas are selected.

Figure 4 shows the temperature variation for the transversal “Patreos” street and the longitu-

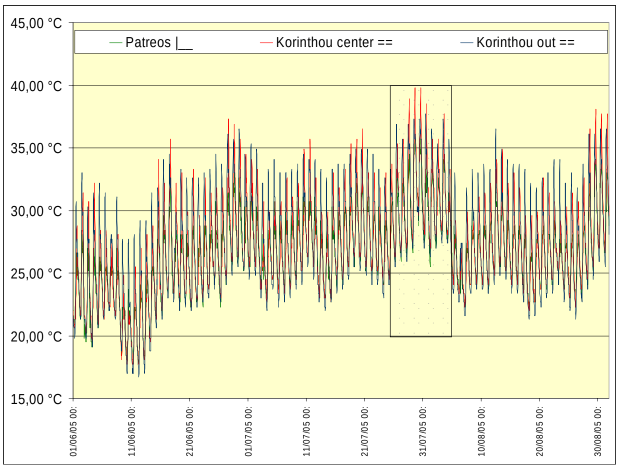

Figure 4: Temperature profiles for transversal (|_) and longitudinal (==) streets.

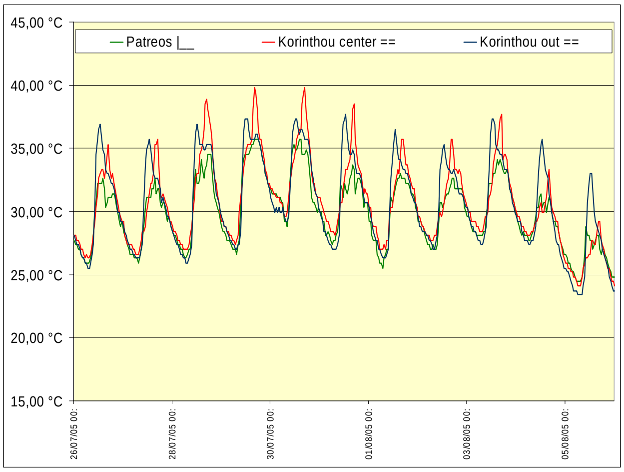

Figure 5: Temperature profiles for transversal (|_) and longitudinal (==) streets.

dinal “Korinthou” street. Specially, for the longitudinal street two sets of data are presented, one for the center and another for its ending portion, outside the center.

Figure 5 clarifies the plots of Fig. 4, magnifying the dashed area of the Fig. 4. As shown in both figures, the transversal street has lower temperatures than the longitudinal one (even for the outside part).

Figures 6-9 depict the temperature variations for urban and rural regions. In Fig. 6 the comparison is made between the longitudinal "Korinthou" street (urban) and the rural place of "Ag. Vasilios". As it is shown, the upper peaks have quite the same magnitude, while the rural region develops lower down peaks.

Figure 7 indicates an almost different situation. As urban place, the up-town "Pantokratoros" street is selected, which lies near the forest hill of the town, thus characterized as "sub"urban. Comparison with the rural region of

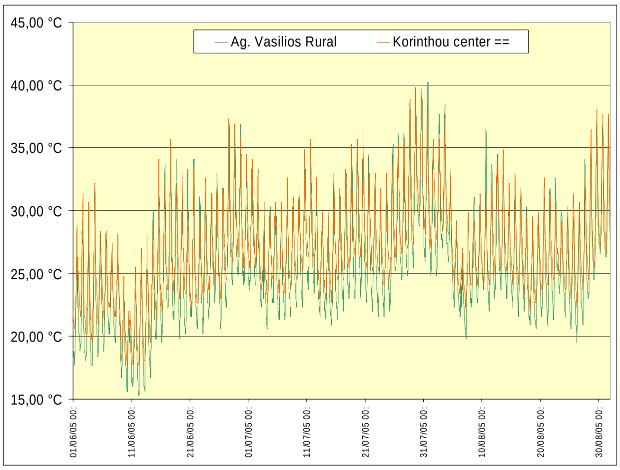

Figure 6: Temperature profiles for urban and rural regions.

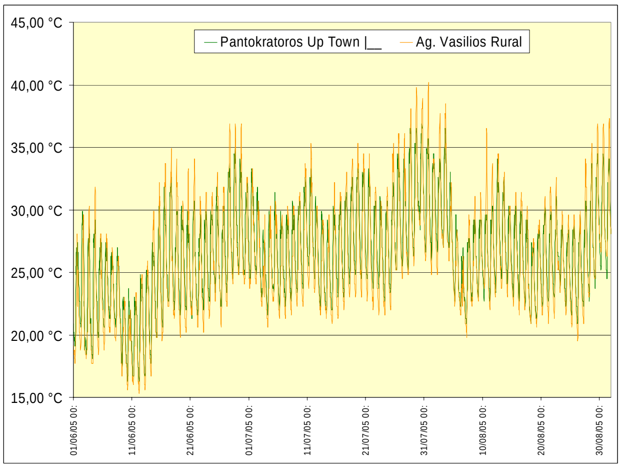

Figure 7: Temperature profiles for "sub"urban and rural regions.

"Ag. Vasilios" indicates that the rural area develops higher daily and lower night temperatures. In order to understand better this behavior, two more figures are given.

As it is shown in Figures 8 and 9 (Fig. 9 shows a magnification of the shaded area of

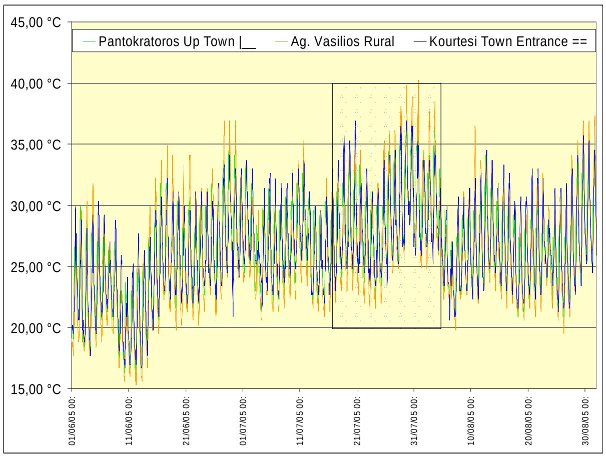

Figure 8: Temperature profiles for urban, "sub"urban and rural regions.

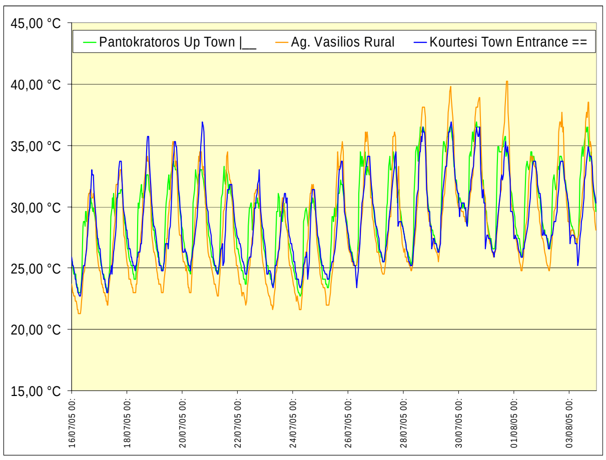

Figure 9: Temperature profiles for urban, "sub"urban and rural regions.

Fig. 8), the rural region develops higher daily peak temperatures, always than the "sub"urban place and many times than the urban place (at the entrance of the town). The rural night temperatures are always lower than both urban and "sub"urban.

4. CONCLUSIONS

As it is expected, transversal to the sea streets develop lower temperature rise, than longitudinal ones, as a result of cooling effects by wind currents.

In most cases, rural areas develop higher daily temperatures and always lower ones during nights. This happens because rural areas accept higher insolation values (compared to the penetrating solar radiation inside urban areas) and develop higher cooling rates during nights. Also, other factors, such as the wind direction, play significant role to the arisen differences between rural and urban areas.

As a final conclusion, it would be said that the Heat Island phenomenon appears to be much less intense for a medium size coastal non industrialized town, like Patras.

Further research must be carried out, taking into account wind currents, street view factors and other influencing parameters, in order to describe better this behaviour.

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