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Local Warming in the Historical Center of Naples

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ABSTRACT

Urban Heat Island (UHI) is a physical process getting more and more hazardous for people living in a large city. It can be influenced by several factors such as geomorphological context, the presence of lakes, rivers or sea, the land use and urban features with special regard to the presence of extended green areas/infrastructures. The metropolitan area of Naples is heavy affected by UHI in a very complex manner due to the simultaneous action of various morphological and orographic factors (e.g. presence of hills and closeness to sea surface) so to prevent the quantification of each percentage weight. This large amount of parameters makes it difficult to identify a clear relationship with urbanization features. Therefore, it is strictly necessary to enhance the knowledge of urban micro-climate by focusing on the evolution of the temperature and relative humidity. To obtain a clearer representation of the process, we propose a methodology based on the collection and the analysis of a specific set of high quality data. An appropriate study of this phenomenon has to be carried on by analyzing directly thermo-hygrometric data measured by appropriate local sensors instead of remote sensing technologies which could lead distorted scenarios. The goal is to characterize the thermal properties of the atmosphere layers below 50 m above the ground. In fact, people live within the "building envelope" that is thermo-hygrometrically regulated. Once the sites are properly identified, the appropriate meteorological methodology can be used to analyze the basic thermo-hygrometric data. This study will provide only a thermo mapping of the metropolitan area of Naples that could be used in improving the city living conditions. The paper briefly describes the UHI phenomenon in the city of Naples and specifically analyzes the meteorological scenarios occurred during the summers 2014 and 2015.

Keywords: Urban heat island, Local warming, Meteorological parameters.

1. INTRODUCTION

Urban Heat Island (UHI) is the typical local warming process occurring in a large city [1,2]. UHI is induced by distinct physical mechanisms and it increases the global planetary warming. UHI is a significant warming excess occurring in urban areas relative to the surrounding countryside areas. In densely urbanized areas, UHI reduces comfort and livability. The situation is worsen mostly in summertime because of enhanced heat waves that could lead to emergency conditions [3,4].

UHI is a small-scale, local warming anomaly that should not be confused with the global surface warming that the Earth is experiencing since 1850 [5,6]. The surface temperature records are claimed to have been adjusted to remove non-climatic effects such as urbanization and measurement discontinuities. However, doubts about the efficiency of the implemented UHI filtering methodologies are also well documented [7]. Thus, a certain amount of leftover UHI could still be hidden in the global surface temperature records and could be artificially contributing to the observed global warming.

This work briefly describes the UHI phenomenon in the city of Naples: it specifically analyzes what happened during summer 2014 and 2015. The year 2015 has been considered one of the hottest of 21th century. We characterize the environment of the historical center of Naples by creating an useful thermo database. This allows to correctly evaluate the heat dispersion of buildings and their energetic performance.

2. THE UHI OF NAPLES

The meteorological data were collected at the Meteorological Observatory of S. Marcellino belonging to the University of Naples Federico II, located in the center of Naples and active since 1872. These data determine that the climate of Naples is subtropical, maritime and weakly humid. Statistically significant changes have been observed in the thermo-rainfall regime with reduced intermediate seasons [8]. More intense rain showers occurred after long periods of

drought and an increasing number of cloudy days [9]. The analysis of air temperature differences, recorded simultaneously in the center of Naples and in its periphery at various distances allows to determine the UHI intensity: see Figure 1.

Table 1 lists three groups of locations at increasing distances from the historical center of the city up to about 60 km from Naples. For each group, Table 2 reports the average maximum and minimum air temperatures from 1920 to 2005. The table indicates that the center of Naples is about 2 °C warmer than the surrounding environment.

Table 1. List of meteorological stations utilized in the evaluation of UHI

Meteorological stations	Id.	Lat. N	Long. E	Height (m asl)
Napoli, S. Marcellino	OG	40°51’	14°13’	50
Napoli Servizio Idrografico	SI	40°51’	14°13’	30
Napoli Capodimonte	OA	40°52’	14°15’	149
Osservatorio Vesuviano	OV	40°49’	14°24	612
Napoli Capodichino	AM	40°51’	14°13’	72
Portici	Po	40°49’	14°21’	82
Torre del Greco	TG	40°47’	14°20’	19
Sorrento	Sr	40°37’	14°24’	28
Ischia	Is	40°45’	13°53’	23
Procida	Pr	40°48’	14°02’	50

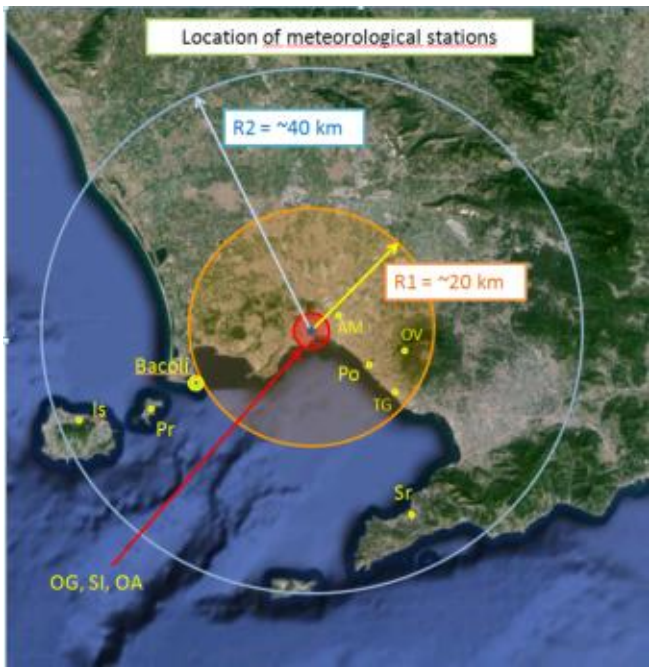

Figure 1. Meteorological monitoring network

To evidence and confirm that the UHI overlaying the historical center of Naples is a consolidate feature of local climate, we have compared local air temperature data against those observed in a location external to the historical center. The latter is not influenced by densely built areas: see Tables 1 and 2.

In the following section, we compare the daily temperature records of July 2014 and of July 2015. The former month was characterized by temperatures below the average while the latter was characterized by temperatures above the average.

Table 2. Temperature data (from 1920 to 2005) grouped in relation to the distance from the center of Naples

Meteorological stations	Tmax (annual average)	Tmin (annual average)
Urban stations (OG, SI, OA)	21.6°C	13.3°C
Peripheral stations (AM, OV, Po, TG)	20.1°C	12.3°C
Far away stations (Is, Pr, Sr)	19.7°C	11.9°C

3. DATA

We utilize data collected at the Meteorological Observatory of S. Marcellino (40°51’ N ; 14°13’ E ; 50 m asl) that are well representative of the historical center of Naples, and at the station of Bacoli located about 20 km West of Naples (40°48’ N ; 14°05’ E) very close to the sea (C.N.R.-I.A.M.C. – Project: PON MON.I.C.A.).

Figures 2 and 3 show the view toward East from the tower of the Meteorological Observatory of S. Marcellino in Naples and Figures 4 and 5 the view toward West from the Meteorological Station of Bacoli.

Figure 2. View of Naples taken from the Meteorological Observatory of S. Marcellino. An uninterrupted layer of building roofs is evident. The interposed streets are made in bitumen or black volcanic rocks. Such elements are very prone to over-heat and to re-emit infrared radiation.

4. ANALYSIS

Tables 3 and 4 report the daily maximum air temperature (Tmax) records from the meteorological stations of S. Marcellino in Naples and of Bacoli observed in July 2014 and in July 2015.

The historical center of Naples was warmer than Bacoli by $\Delta T = 1.9 \pm 1.0$ °C in July 2014, and by $\Delta T = 2.1 \pm 1.1$ °C in July 2015.

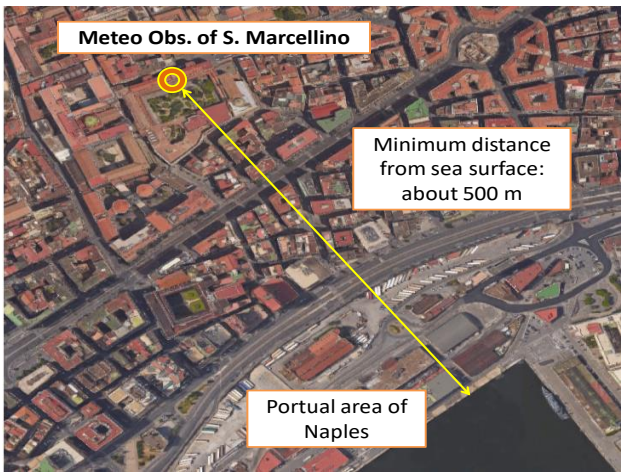

Figure 3. Position of the Meteorological Observatory of S. Marcellino: the site is about 500 m from the sea.

Figure 4. Position of Bacoli Meteorological station: the site is very close to the sea.

Figure 5. The Miseno lake located between Bacoli and Monte di Procida, showing an extremely low urbanization of the region.

Table 3. Daily Tmax July 2014

	S. Marcellino °C	Bacoli °C
01/07/14	26.7	25.3
02/07/14	28.0	25.4
03/07/14	32.0	29.1
04/07/14	31.7	28.3
05/07/14	28.6	26.6
06/07/14	28.7	26.9
07/07/14	30.4	27.3
08/07/14	27.8	26.9
09/07/14	25.8	24.5
10/07/14	25.1	23.5
11/07/14	25.4	24.0
12/07/14	25.4	25.1
13/07/14	25.7	24.6
14/07/14	25.2	24.6
15/07/14	27.5	25.2
16/07/14	32.1	27.1
17/07/14	31.3	28.7
18/07/14	32.1	29.0
19/07/14	31.7	29.3
20/07/14	30.8	28.3
21/07/14	28.8	26.8
22/07/14	25.0	24.0
23/07/14	27.8	25.8
24/07/14	28.6	26.8
25/07/14	29.0	26.7
26/07/14	29.9	28.1
27/07/14	28.3	26.5
28/07/14	27.8	26.8
29/07/14	28.4	26.8
30/07/14	27.2	26.2
31/07/14	26.7	25.1
MEAN	**28.4**	**26.4**

The two diagrams depicted in Figures 6 and 7 show also that the temperature in Bacoli has always been lower than in S. Marcellino by about 2 °C throughout the two months.

5. CONCLUSIONS

The analysis shows that the air temperature differences between the center of Naples and the surroundings areas are significant. This confirms the UHI affecting the historical center of Naples.

In July 2014, a month affected by a relevant negative anomaly (-1.6°C), Naples has been warmer than Bacoli by about 2°C. The same behavior has been observed in July 2015, a month affected by a relevant positive anomaly (+2.0°C). Also in this case ΔT has been about 2°C.

This is a clear representation that the thermal excess in historical center of Naples is a structural feature, related to the peculiarities of site.

Table 4. Daily Tmax July 2015

	S. Marcellino °C	Bacoli °C
01/07/15	30.9	29.1
02/07/15	31.1	28.4
03/07/15	32.9	29.2
04/07/15	32.9	29.8
05/07/15	31.3	29.0
06/07/15	30.1	28.6
07/07/15	30.6	28.9
08/07/15	29.8	29.2
09/07/15	30.1	28.8
10/07/15	33.3	30.6
11/07/15	31.8	29.3
12/07/15	31.9	28.9
13/07/15	29.6	29.5
14/07/15	32.1	29.6
15/07/15	34.2	32.1
16/07/15	32.9	30.9
17/07/15	36.7	33.3
18/07/15	36.9	32.4
19/07/15	35.1	30.9
20/07/15	32.6	30.3
21/07/15	33.9	30.7
22/07/15	32.2	30.9
23/07/15	31.2	30.8
24/07/15	30.8	29.7
25/07/15	30.7	29.5
26/07/15	31.9	29.3
27/07/15	29.4	28.3
28/07/15	30.4	29.2
29/07/15	28.8	28.0
30/07/15	32.1	31.2
31/07/15	34.0	30.9
MEAN	**32.0**	**29.9**

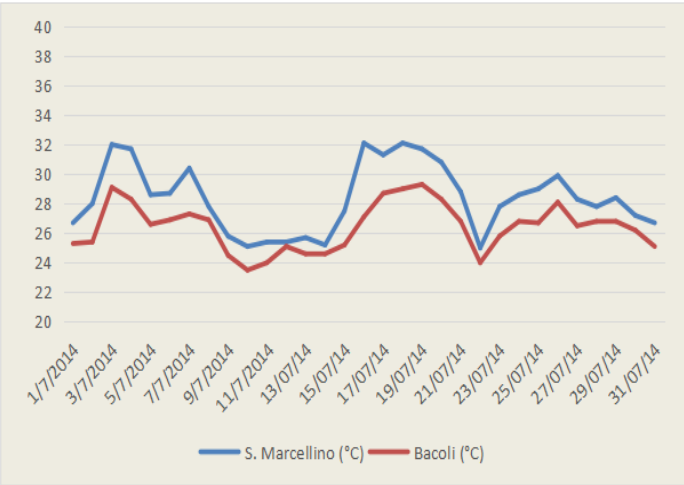

Figure 6. Maximum temperature records measured in the observatories of S. Marcellino and of Bacoli in July 2014.

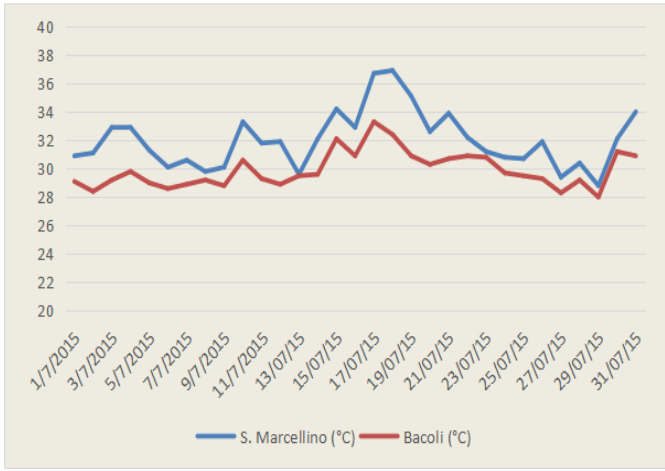

Figure 7. Maximum temperature records measured in the observatories of S. Marcellino and of Bacoli in July 2015.

REFERENCES

[1] Bottyan, Z., Kircsi, A., Szegedi, S., Unger, J., "The relationship between built-up areas and the spatial development of the mean maximum urban heat island in Debrecen, Hungary". *Int. J. Climatology*, vol. 25, pp. 405-418, 2005. DOI: 10.1002/joc.1138.

[2] Palumbo, A., Mazzarella, A., "The heat-island over Naples". *Weather*, vol. 36, pp. 28-29, 1981.

[3] Di Cristo, R., Mazzarella, A., Viola, R., "An analysis of heat index over Naples (Southern Italy) in the context of European heat wave of 2003". *Natural Hazards*, vol. 40, pp. 373-379, 2007. DOI: 10.107/s11069 -006-0033-7.

[4] Li, D., Bou-Zeid, E., "Synergistic interactions between urban heat islands and heat waves: the impact in cities is larger than the sum of its parts". *J. of Applied Meteorology and Climatology*, vol. 52, pp. 2051-2064, 2013. DOI: 10.1175/JAMC-D-13-02.1.

[5] Mirandola, A., Lorenzini, E., "Energy, Environment and Climate: From the Past to the Future." *International Journal of Heat and Technology*, vol. 34, pp. 159-164, 2016. DOI: https://doi.org/10.18280/ijht.340201.

[6] Scafetta, N., "Problems in Modeling and Forecasting Climate Change: CMIP5 General Circulation Models versus a Semi-Empirical Model Based on Natural Oscillations." *International Journal of Heat and Technology*, vol. 34, Special Issue 2, pp. S435-S442, 2016. DOI: 10.18280/ijht.34S235.

[7] McKitrick, R. R., Nierenberg N., "Socioeconomic patterns in climate data". *J. Econ. Soc. Meas.*, vol. 35(3,4), pp. 149–175, 2010. DOI: 10.3233/JEM-2010-0336.

[8] Palumbo A., Mazzarella A., "Local recent changes in extreme air temperatures". *Clim. Change*, vol. 6, pp. 303-309, 1984, DOI: 10.1007/BF00142478.

[9] Palumbo, A., Mazzarella, A., "Rainfall statistical properties in Naples". Mon. Weath. Rev., vol. 108, pp. 1041-1045, 1980. DOI: 10.1175/1520-0493(1980)108<1041:RSPIN>2.0.CO;2.