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Urban heat island in Padua, Italy: Simulation analysis and mitigation strategies

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ABSTRACT

The paper reports on the study of the UHI phenomenon in Padua, a medium size city of the North-East of Italy. During the 2012–2014 period experimental measurements and simulations were carried out by the Authors in different zones of the city area: urban, sub-urban and rural. The analysis of the data highlights the presence of UHI effect with different magnitudes in function of the zone of the city, up to 7 °C.

In this study a very famous square of the city (Prato della Valle) was analyzed: it can be considered representative of the phenomenon because of the size and the very different characteristics from UHI effect point of view. The ENVImet simulation model was used to evaluate the effect of some mitigation strategies. Two scenarios besides the actual one ("AsIs" scenario) were analyzed: "Green ground" (halving the asphalt surface and doubling the green and plants surface) and "Cool Pavements" (increasing the albedo of impervious horizontal surfaces). The simulations results are presented both in terms of UHI intensity and mean radiant temperature and thermal comfort sensation. The results are presented both in spatial and temporal terms for a typical summer day. The "Green ground" scenario allows till 1.4 °C and 3 °C decrease in air temperature, respectively during the night and the day. The same items for the "Cool Pavements" scenario are, respectively, 1.8 and 4 °C.

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Nomenclature

AT	air temperature, °C
H	mean height of buildings along a street, m
MRT	mean radiant temperature, °C
PET	physiological equivalent temperature, °C
PMV	predicted mean vote
SET*	new standard effective temperature, °C
SVF	sky view factor
UHI	urban heat island
UHII	urban heat island intensity, °C
UTCI	Universal Thermal Climate Index, °C
W	mean width of a street, m

1. Introduction

As it is well known, the Urban Heat Island phenomenon (UHI) is the systematic higher air temperature of urban environment with respect to rural one. It results from a lot of causes that interact with one another, according to the particular situation of each city (Lazzarin, 2011). Briefly, the main factors are the following:

- the structure of urban canyons that affect the shortwave radiation heat exchange capacity of the urban surfaces toward the sky;
- the typically low albedo of the urban surfaces that increase the heat absorbed by buildings, pavements, roads and roofs;
- the anthropogenic heat produced by heat engines of the motorcars and chillers condensation heat;
- the greenhouse effect that is amplified by the higher pollutants concentration in the urban atmosphere;
- the shortage of green areas that increases the sensible heat exchange with air and decreases the evaporative cooling effect due to the lack of evapotranspiration of trees and grass.

The literature on the UHI effect is very rich; for sake of brevity refer to Authors' previous work (Noro et al., 2014a) to find some references. UHI has been studied worldwide (Athens, London, Berlin, Vancouver, Montreal, New York, Tokyo, Hong Kong for example) since the sixties of the past century (Santamouris, 2007). In Italy, only few studies are available for some major cities like Bologna (Zauli Sajani et al., 2008), Milan (Bacci and Maugeri, 1992), Florence (Petralli et al., 2006, 2009, 2011) and Rome (Fabrizi et al., 2010). Very few data are available concerning the existence of the urban heat island phenomenon in medium size cities, the most widespread in Italy (Modena (Bonafè, 2006) and Trento (Lora et al., 2006; Giovannini et al., 2011) for example), and none in the Veneto Region in the North East of Italy.

The University of Padua has been studying the Padua city's UHI effect since 2010. In previous works the Authors have described the results of the 2010–2011 measurement campaigns done by the research group of the Department of Environmental Agronomy and Crop Productions and the 2012 measurement campaign by the Authors' research group within the framework of the European Project "UHI"[1] (Busato et al., 2014; Noro et al., 2014a, 2014b). The main scope of this work is to evaluate the presence of the UHI phenomenon and to investigate the effect of possible mitigation strategies in a representative site of the city, the famous Prato della Valle circle, by means of the ENVImet simulation model.

[1] "UHI- Development and application of mitigation and adaptation strategies and measures for counteracting the global Urban Heat Islands phenomenon" (3CE292P3).

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