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THERMAL CHARACTERIZATION OF URBAN HEAT ISLAND (UHI) ACCORDING TO URBAN MORPHOLOGY OF MADRID

López Moreno, Helena [(1)]; Sánchez-Guevara Sánchez [(1)], Román López, Mª Emilia[(2)]; Neila González, Fco. Javier[(1)].

(1) Departamento de Construcción y Tecnologías Arquitectónicas de la UPM, Spain.
(2) Departamento de Urbanística y Ordenación del Territorio de la UPM, Spain

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1. Introduction – Present research is framed within the project MODIFICA (MODelo predictivo - edIFIcios - Isla de Calor urbanA) aimed at developing a predictive model for dwelling energy performance under the urban heat island effect in order to implement it in the evaluation of real energy demand and consumption of dwellings as well as in the selection of energy retrofitting strategies. It is funded by Programa de I+D+i orientada a los retos de la sociedad 'Retos Investigación' 2013.

The scope of our predictive model is defined by the heat island effect (UHI) of urban structures that compose the city of Madrid. In particular, we focus on the homogeneous areas for urban structures with the same urban and building characteristics. Data sources for the definition of such homogeneous areas were provided by previous research on the UHI of Madrid [1].

The objective is to establish a critical analysis of climate records used for energy simulation tools, which data come from weather stations placed in decontextualized areas from the usual urban reality, where the thermal conditions differs by up to 6ºC [2]. In this way, we intend to develop a new predictive model for the consumptions and demands in buildings depending on their location, the urban structure and the associated UHI, improving the future energy rehabilitation interventions.

2. Methods – The first part of this study consisted on cataloguing and characterizing the morphology of the urban areas of Madrid. This analysis identified 9 homogenous areas of urban structures of Madrid, each of which was quantified in them of its morpho-typological characteristics. [3] [4]. The list of homogenous areas is summarized below.

HOMOGENEOUS URBAN AREA	NEIGHBORHOOD TYPE
Historic area (HA)	Sol
Planned growths, square block high altitude (PSH)	Goya
Planned growths, rectangular block high altitude (PRH)	Delicias
Planned growths, rectangular block low altitude (PRL)	Quintana
Spontaneous growths (SG)	Berruguete
Open building (BA)	Barrio del Pilar
Pheriferical extensions (PE)	Acacias
Communal courtyard closed block (CCB)	Palomeras Bajas
Single family house (SFH)	Piovera

Figure 1 Classification of homogeneous urban areas for the city of Madrid. Personal source.

A study titled "The urban climate. Remote sensing of UHI of Madrid" [1], was presented in 1993, establishing the isotherms within the city of Madrid. We used data provided by this previous study as an starting point for assigning temperature values for each neighborhood.

We further study the energy consumption during summer nights, when the energy consumption is known to be particularly unfavourable. This is because urban areas experiment a relative large temperature increment caused by the UHI, which ultimately results in a widespread usage of refrigeration equipments. Figure 2, depicts the thermal differences across neighborhoods in the city of Madrid. The highest temperature values are reached in the city center, with an average value of 28ºC. The tendency of temperature values is to decrease while moving towards the periphery, where average temperature eventually drops to 23ºC.

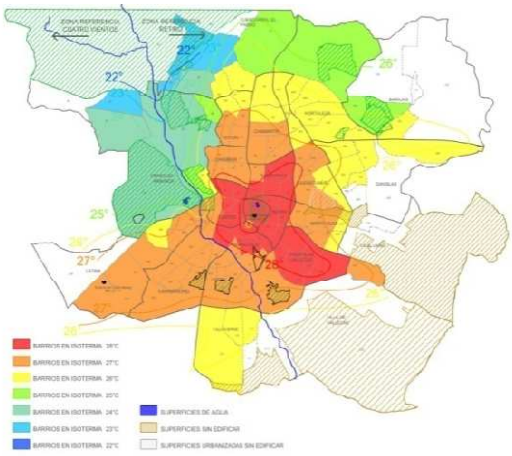

Figure 2. Temperature of the neighborhoods of Madrid, summer-night. Personal source.

3. Results and Discussion– As is shown in the figure 3, the previous analysis clearly evince the influence of urban morphology on the temperature of the city, and its correlation with homogeneous areas with the same isotherm type. It is noted that the historic center (HC) and planned growths (PSH, PRH and PRL) have the higher temperatures recorded (27ºC and 28°C), the open buildings (OB) show high-medium temperature (26°C and 27°C), communal courtyard closed blocks (CCB) have medium values (25°C), peripheral extensions (PE) cover the strip of the 24ºC- 27ºC,due to typological variety and finally single-family house (SFH) reached the lowest values (23°C). Results of the thermal performance and energy consumption of different building typologies are yet to come and are expected to be presented in the conference.

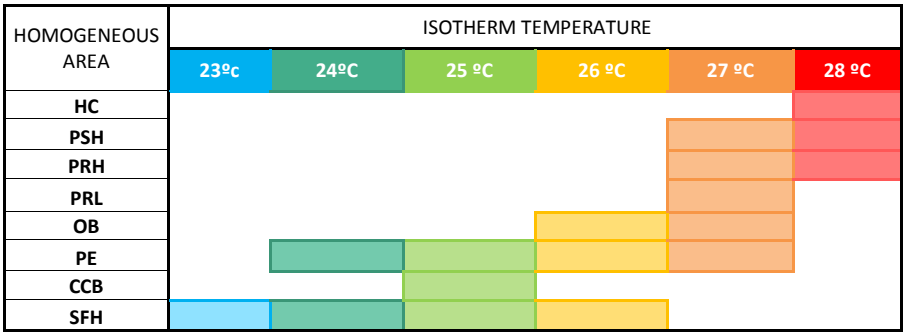

Figure 3. Relation between homogenous areas and isotherm where is located. Personal source.

3. Conclusions - First results show strong differences in microclimatic conditions amongst different urban morphologies. It can be drawn that these differences of up to 5 degrees pose relevant deviations in the thermal performance of dwellings and must be relevant in the decision making process of energy retrofitting

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