Available online at www.sciencedirect.com

ScienceDirect

Procedia Environmental Sciences 38 (2017) 619 – 626

Procedia Environmental Sciences

International Conference on Sustainable Synergies from Buildings to the Urban Scale, SBE16

Comparison of the impact of three climate adaptation strategies on summer thermal comfort – Cases study in Lyon, France

Benjamin Morille[a,b,*], Marjorie Musy[a,b]

[a]*Ensa Nantes, CRENAU UMR CNRS/ECN/MCC 1563, 6 quai F. Mitterrand, Nantes, France*
[b] *IRSTV, FR CNRS 2488, 1 rue de la Noé, 44300 Nantes, France*

Abstract

Nowadays, the study of the outside thermal comfort is more and more taking into consideration in the urban design process. In a climate change context, town planners have to find solutions to mitigate the effects of the global warming and to ensure that outside spaces designed in new districts will remain liveable.
In the framework of the EVA project, simulations were carried out to compare the effect of three urban cooling strategies on the thermal comfort in summer. Various urban greenery types, water aspersion systems and cooling materials are applied to three districts in Lyon, France. A set of simulations was designed to explore different configurations:
- cooling strategies were first applied one by one in each district,
- a composition of the three strategies is considered in a second step to optimize their effect,
- cumulative effect is finally investigated by deducing one of the components from the optimized configuration.
Simulations were performed using *Solene-microclimat* which realizes the full coupling between a CFD code and a thermo-radiative model. In this way, *Solene-microclimat* enables to calculate and evaluate the evolution on the urban microclimate at a district scale considering physical parameters in a completely discretized way. Modules have been introduced in this model to represent different kinds of adaptation strategies such as vegetation (green roofs and walls, trees, lawns) and water aspersion. For each case, the daily variations of surface and air temperatures fields are obtained and compared. The resulting mean radiant temperature is evaluated and investigated for the studied space of each district. Finally, the thermal comfort is assessed using the UTCI index. Findings indicate that vegetation, in particular when including trees is the more efficient, due to its shading effect. Even if water aspersion can strongly lower the surface temperatures, its effect on thermal comfort is local and limited compared to the effect of vegetation. Due to reflection effects, high albedo materials are less efficient concerning external thermal comfort.

Peer-review under responsibility of the organizing committee of SBE16.

Keywords: *Thermal comfort; water aspersion; vegetation; cool materials; urban climate; Solene-microclimat*

1. Introduction

The study of the urban cooling solutions ability to mitigate the global warming effects is nowadays prime of interest in the district design process. The papers dealing with the comparison of the urban cooling solutions become numerous. Most of them investigate the impact of vegetation[1-4] or compare it with cool surfaces[5-8]. Solutions using water[9,10] in a direct way are not very often studied. In particular, no paper comparing solutions with water aspersion systems and using numerical approach was found. The air temperature and the mean radiant temperature are almost

Peer-review under responsibility of the organizing committee of SBE16.
doi:10.1016/j.proenv.2017.03.141

always investigated in these papers. The comfort is most of the time studied through the PMV[6] or the PET[1,5,7,8] comfort index. UTCI is not often considered to compare the impact of urban cooling solutions on outdoor comfort or only to examine one case study[11,12]. Moreover, these studies were only carried out using the ENVI-met software. Lastly, the impact of the urban form on the cooling solution efficiency[4] is not often investigated.

The aim of this paper is to compare the ability of three urban cooling solutions to enhance outdoor comfort. A set of 24 simulations was carried out with the microclimate tool SOLENE-microclimat. The three studied solutions (water aspersion systems, the use of the vegetation and the modification of the surfaces albedo values) were differently implemented in three districts in Lyon, France.

The different scenarios defined for the project are firstly presented: the current configuration of the districts, the three configurations of the districts where only one of the solutions is implemented and the districts with all the solutions simultaneously implemented. As results, mapping of surface temperature, air temperature and UTCI reductions at midday are analyzed. The comparison of the different solutions is finally summarized for each district and the contributions of each solution to the scenario where all the solutions are implemented are investigated.

2. Methodology of EVA project

2.1. EVA project

The EVA project seeks to compare three different urban cooling strategies: the use of vegetation, water aspersion systems, and cooling materials. In the project, the impacts on the building energy needs, inside and outside comfort are studied. This paper only focuses on outside thermal comfort aspects. A set of simulations was designed to explore different configurations:

- cooling strategies were first applied one by one to each district,
- a composition of the three strategies is considered in a second step to optimize their effect,
- cumulative effect is finally investigated by deducing one of the components from the optimized configuration.

The study investigates one outside space (highlighted in red) of different kinds of district (Fig. 1): the Francfort square in front of the Part Dieu train station, the square between the two Moncey building blocks (residential district build in the 60's) and the Buire street (recent residential district).

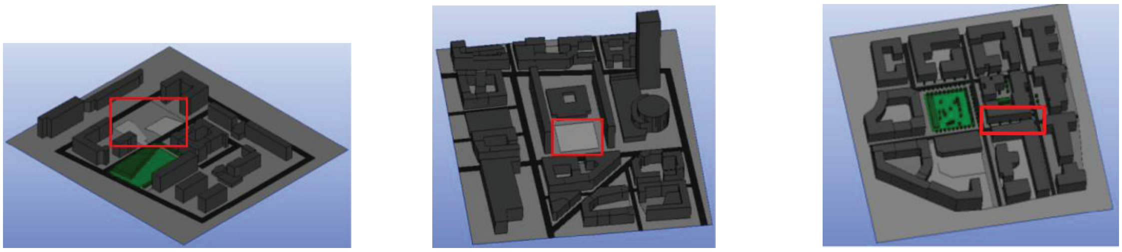

Fig. 1. Design of the three studied districts in Lyon, France and considered as the reference cases: Francfort square district (left), Moncey building blocks district (center) and Buire street district (right).

These representations of the districts are considered as the reference case for the results comparison. The three cooling strategies were applied taking into account the realistic possible evolutions of the urban planning.

2.2. Scenarios definition

The "water scenario" consists in the use of water aspersion systems over all the roads of the districts as well as the two studied squares in Francfort district and in Moncey district (Fig. 2).