

The effects of green spaces (Palme trees) on the microclimate in arides zones, case study: Ghardaia , Algeria

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Abstract

The microclimate and air quality in urban spaces are of a great interest for the well-being of citizens. Mitigating urban heat island is a major concern for human health by improving comfort especially in desert regions. While the thermal comfort is relatively easy to obtain in indoor spaces, it is more difficult to provide in outdoor ones. It is often sought by passive means. Vegetation could play an important role in ameliorating urban microclimates. It should be used judiciously in urban planning and designing outdoor spaces. The objective of this work is to explore the influence of green cover during summer on microclimate in the region of Ben-Isguen, a city of a hot-arid climate in the M'zab valley, Ghardaïa (Algeria). Many studies have proved that vegetation can produce a cooling effect of 2 to 3 °C on average. Gardens and urban parks in particular, in and around cities contribute to alleviating heat stress by creating the so-called "oasis effect" through public spaces. They improve thermal comfort and reduce cooling energy consumption. The microclimate of different locations, in both green and built-up areas (old town, palm grove, etc.) was characterized with the help of field measurements carried out during summer days. The results confirmed the presence of an important cooling effect of vegetation (PCI). It was shown that it is essentially a nocturnal phenomenon by displaying a maximum value of 10 °C. This result is very important regarding the results of similar studies. The research demonstrated that the oasis effect is best developed around dawn in calm and clear sky conditions. Maximum daytime cooling effect of the green cover was 4.5 °C in reference to old town. Nevertheless this effect showed fluctuation so that it displayed negative values by moments. The cooling effect of the palm grove is due to shade foliage, evapotranspiration, low heat capacity of vegetation and high aerodynamic roughness. In fact the oasis acts as a "heat sink". The old town of Ben-Isguen presented a diurnal heat island and a nocturnal cool island with maximum intensity of 3.5 °C and 4 °C respectively. The investigation of the oasis microclimate revealed that densely vegetated areas display higher cooling effect. The latter varied among different areas due to shade conditions, density of vegetation, sky view factor (SVF), soil characteristics and water surface availability.

Key words: microclimate, urban space, heat island, green space, arid zone.

1. Introduction

In the past, Mزاب settlements (the ksurs and their cities gardens) were developed in response to both cultural and climatic needs of their inhabitants [1], the inhabitants of Mزاب site use detached houses in Palme trees gardens for day living and the ksurs for night living (due to security problems) and now they use garden houses for day and night living during summer period. Our study investigates the effects of vegetations on the outdoor temperatures in hot arid zones, and Ghardaia in the south of Algeria was taken as a case study.

Vegetation cover has positive effects on the microclimate [2], it can lower the outdoor temperature [3-4-5]. Many studies on urban tree cover like green CTTC (cluster thermal time constant) model have indicated a very high correlation between daily outdoor temperature and consumption of space conditioning energy [6-7-8]. It is assumed that a tree has a projection area of shading and a reduction of sky view factor, in the air surrounding a tree always has a high humidity due to tree irrigations system. The surrounding space between detached houses in Palme trees are well protected from solar radiations and the surrounding air is usually saturated with humidity, which can affect directly the outdoor temperature. M. Santamouris [9] shows that trees with a crown of 8m could reduce the peak cooling load by 2 to 10%. Akbari [7], found that trees reduce the cooling load by 21- 53% in California. This paper studies the effect of Palme trees on microclimate in arid zones, and Ghardaia in the south of Algeria (32.3°N – 3.49°E) was taken as a study case.

2. Study area

Ghardaia is located in the south of Algeria, which is well known by its hot arid climate, its ksurs (dense old buildings), its river, and its detached houses surrounded by Palme trees as shown in figure (1). The climate of Ghardaia is characterized by a very hot dry summer, the mean summer temperature in July is 36.8°C and the maximum absolute temperature is 46°C.

The outdoor temperatures were recorded in four different sites in addition to the reference point; Figure (2) shows the different sites where field measurements were recorded.

The reference point is situated at the frontier of Palme trees site on the top of the local radio building and the first site, detached houses in Palme trees (Oasis) is situated at the bottom of the valley as shown in figure (3). The second site called Beni Ezgen ksur, the old part of the city (high density buildings and partially covered narrow streets as shown in figures (4, 5). The third site the new city extension called Tafilalt and the fourth site is the new detached houses in open area without vegetations.

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