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Courtyard Building's Morphology Impact on Thermal and Luminous Environments in Hot and Arid Region

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Abstract

This paper investigates in indoor thermal and luminous environments of the existing courtyard buildings in an arid area, in order to identify daylighting strategies and thermal comfort conditions in this type of building. As Biskra town is situated in the hot and dry region of Algeria and facing a hot and intense radiation, drives us to seek a balance between thermal and luminous environments. During summer and winter seasons, monitoring campaigns have been conducted to collect temperatures and illuminance levels data using a digital monitoring instrument "LM/FI 20"; these on-site measurements intend to assess courtyard impact on it adjacent spaces under clear sky conditions. A Special attention based on courtyard building's architecture of different morphologies and periods such as: traditional, colonial, post-colonial and contemporary samples. The selection of relevant samples morphologies can reveal many strategies on climate adaptation under local conditions. The important findings are related to the high potential for natural lighting and thermal control that courtyard building offer, and later, discovered the relationship between the morphological indicators and the qualities of thermal and luminous environments of adjacent spaces, in addition, courtyard remains more effective in controlling, regulating and homogenizing the luminous environment. The trilogy areas surround a courtyard building (Indoor spaces/outdoor/courtyard) are interacting in systemic ways to enhance building's thermal and luminous performances and solve the dilemma between daylighting and protecting the building from hot sunlight in arid areas.

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Keywords: Courtyard building; Morphological indicator; Daylighting; Thermal environment; On-site measurement; Arid climate.

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1. Introduction

Buildings are responsible for an increasing energy use and greenhouse gas emissions. An alternative approach to the way the buildings are designed is needed to improve the environmental performance of buildings and minimize their electricity consumption [7] [5]. Courtyard building is one of the oldest architectural forms, dates back at least 5,000 years and take divers shapes in many regions of the world [2]. The earliest civilizations all had courtyards inside buildings [3]. Courtyards are special spaces that are outside yet almost inside [8]. Few architectural elements are more closely associated with comfort, protection, and security than the courtyard [3]; for all those considerations, we will investigate in courtyard buildings potential as an environmental sustainable morphology and an alternative solution to a new building design; a serene architecture, combined with the environment, taking into account landscape, climate, and local specificities [4].

Thermal and luminous environments influence user's comfort and building energy consumption [10]. However, the natural lighting system might not work independently facing a hot and intense solar radiation [7], which consequently causes overheating that disrupts thermal comfort. The assessment of existing introverted architecture will be useful in finding effective and valuable strategies adequate to thermal and luminous environments. Under a hot and dry climate condition, most research subjects treat thermal and luminous comfort independently. This present research evaluates the overall effects of both daylight and thermal conditions in courtyard buildings and the role of the courtyard as a regulator of indoor comfort conditions.

2. Presentation of the case study

The city of Biskra is located in the South-East of Algeria. Typical of Sahara town, it is characterized by a hot and dry climate most of the year with a short winter extending from December to February. See Table 1.

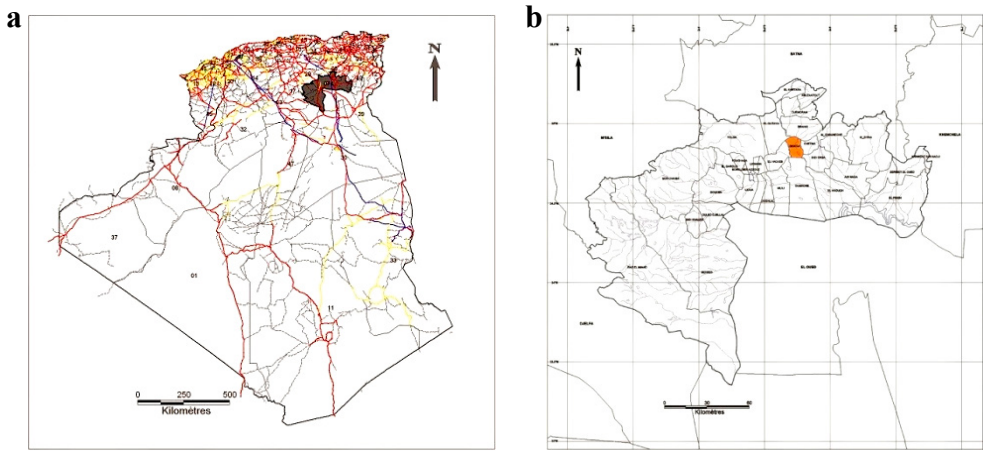

Fig. 1. (a) Algeria map; (b) Biskra map.

Table 1. Climatic data.

Temperature	Relative Humidity	Precipitation
Max. Temp: 42 °C in July	Max. R.H: 50% in January	Max: 200 mm per Year
Min. Temp:7 °C in January	Min. R.H:10% in July	
Average annual Temp: 21.5 °C		