

# Passive environment control system of Kerala vernacular residential architecture for a comfortable indoor environment: A qualitative and quantitative analyses

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## ABSTRACT

The modern day practice does not give due respect to passive and natural environment control measures in buildings. With modern materials and technology, the buildings of present architectural style results in high energy consumption, in an attempt to provide thermal comfort indoors. The vernacular architecture at any place on the other hand has evolved through ages by consistent and continuous effort for more efficient and perfect solutions. The authors have conducted a qualitative analysis of the passive environment control system of vernacular residential architecture of Kerala that is known for ages for its use of natural and passive methods for a comfortable indoor environment. The orientation of building, internal arrangement of spaces, the presence of internal courtyard, use of locally available materials and special methods of construction, etc. have together created the indoor environment. A quantitative analysis was also carried out based on field experiments by recording thermal comfort parameters in a selected building. The study has provided positive results confirming that the passive environment control system employed in Kerala vernacular architecture is highly effective in providing thermal comfort indoors in all seasons.

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## 1. Introduction

Review of vernacular architecture in its ecological concerns suggests that human beings should adapt all their design activities to the natural order of the global system. In the light of this, environmental architecture can be the most appropriate discipline to perform the role of stabilizing the ecological system. The term, environmental architecture, means the architecture adjusted to its surroundings or in harmony with nature creating a healthy environment for human beings by maximizing the utilization of natural energies [1]. Environmental architecture is the one that would provide a comfortable indoor environment in response to the seasonal variations of the climate. Irrespective of the extreme climatic conditions that prevail outside, the building indoors should keep its occupants physiologically comfortable.

The strength of vernacular architecture is that it makes buildings that are in natural harmony with climate, built form and people. Vernacular architecture has evolved through ages where among other factors, the climate has also played a very important role [2–9]. However, the modern practice in architecture lacks conscious effort in using passive methods of controlling the indoor environment [10,11]. Excessive use of modern materials

irrespective of their efficiency in regulating the indoor environment has often resulted in high energy consumption, leading to many environmental problems [12]. Also, energy intensive solutions are required in such buildings to attain comfort conditions in terms of cooling and ventilation. Fortunately there are conscious efforts now to design building that require low energy by utilizing the passive techniques to achieve comfortable cooler indoors.

Kerala has a characteristic warm–humid climate because of its geographic settings. The presence of high amount of moisture in the atmosphere for major part of the year causes thermal discomfort as there is less evaporation, resulting in sweating. Prolonged exposure to such thermal discomfort conditions can create adverse effects including extensive loss of efficiency in work along with physical strain [13,14].

The vernacular architecture of a region derived out of various factors, such as social, culture, etc. gives more importance to local-specific factors such as climate and topography. The principles of vernacular architecture of Kerala are based on empirical observations and experimental wisdoms acquired through generations [15]. The use of natural and passive methods in the vernacular Kerala architecture is attributed to be highly effective in providing thermal comfort in all distinct seasons.

Although there have been attempts to analyze the vernacular architecture of Kerala, they were focused only on one or two parameters and were qualitative in approach [7,13]. It is not

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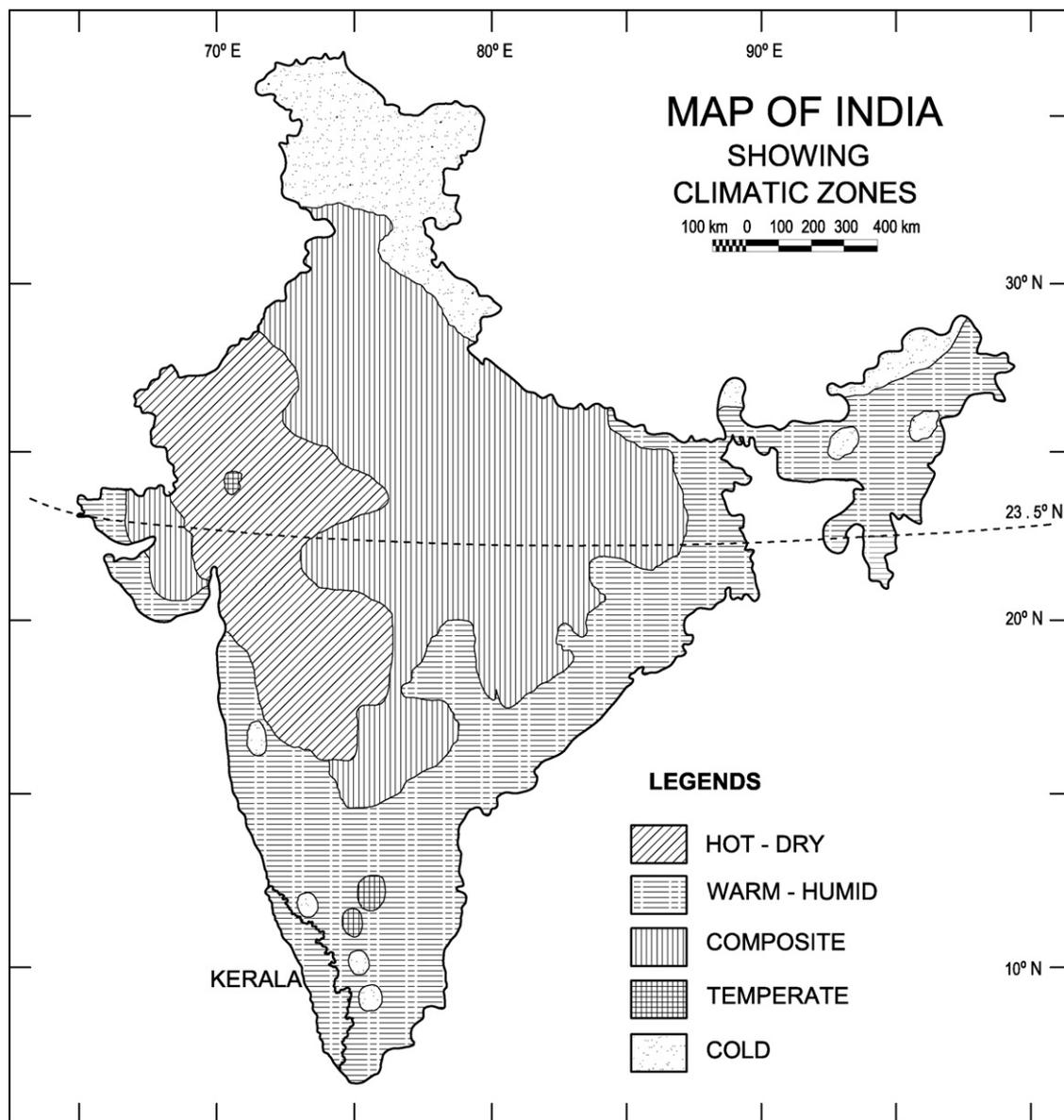


Fig. 1. Climatic zones of India [17].

possible to establish the effectiveness of any passive environment control system without a comprehensive analysis supported by field measurements of all the comfort parameters conducted in all seasons. A quantitative study was thus initiated by the authors by continuously monitoring comfort parameters over a period of time. The results of the investigation carried out during summer and winter seasons have already been reported [16].

This paper illustrates the vernacular architecture of Kerala, a detailed qualitative analysis of typical vernacular residential buildings and a quantitative analysis based on field experiments with emphasis on indoor thermal comfort.

## 2. Kerala: topography and climate

### 2.1. Topography

India is a tropical country with diverse climatic conditions resulting in diverse shelter forms. According to Bureau of Indian Standards [17], the country has been divided into five different regions with distinct climates (Fig. 1).

Extending from  $8^{\circ}18'$  to  $12^{\circ}48'N$  latitude and  $74^{\circ}52'$  to  $72^{\circ}22'E$  longitude, Kerala is on the South-West coast of India lying between the Arabian Sea on the West and the Western Ghats on the East (Fig. 2) in the belt of monsoon zone, which occurs in large land masses that are sufficiently far from the equator to experience marked seasonal changes in solar radiation and wind direction. Even though Kerala comes under warm–humid climatic zone, microlevel variations are observed due to its geographical peculiarities. Based on the altitude, Kerala has three distinct zones—high land (800–2700 m), mid land (300–700 m) and low land (sea level to 150 m), as given in Fig. 2.

### 2.2. Climate

The warm–humid climate of Kerala is characterized by heavy rainfall and high relative humidity, and relatively moderate temperature. In effect, Kerala has only two predominant seasons—rainy and non-rainy seasons. The rainy season lasts for about half of the year where heavy rainfall occurs due to South-West monsoon (locally known as *Edavapathi*) from June to August and

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