



Bioclimatism and vernacular architecture of north-east India

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ABSTRACT

Vernacular architecture based on bioclimatism concepts was developed and used through the centuries by many civilizations across the world. Different civilizations have produced their own architectural styles based on the local conditions. This study is carried out on the vernacular buildings of north-east India across all the bioclimatic zones. A survey of 42 houses, more than 70 years old was carried out at representative locations across all bioclimatic zones. The study has yielded findings relating bioclimatism, socio-economic status and cultural setup to the vernacular architecture of the region. Also, different solar passive features are available in most of these houses, related to temperature control and promoting natural ventilation. These houses are constructed using locally available materials like wood, cane, bamboo, stone, mud, jute, lime and represent unique examples towards sustainable building design.

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1. Introduction

Climate, socio-cultural setup, economy, materials and technology availability are the main factors that greatly influence building architecture and its sustainability. Since climate varies from place to place, favourable architectural solutions for the built environment are also region specific. Vernacular architecture constructed by the people reflects their needs and socio-cultural values [1]. The buildings that are constructed using locally available materials show a greater respect to the existing environment and also take into account the constraints imposed by the climate. Of the various factors that affect architectural design, climate control is of prime importance for maintaining comfortable conditions inside the buildings [2]. Vernacular architecture sets an example of harmony between dwellings, dwellers and the physical environment. But it is often ignored in modern times. However, it may not be appropriate to adopt these models as readymade solutions for modern architecture. Our advanced technical capability and cultural context prevent us from returning to these old-fashioned architectural forms. But we can learn a lesson from the approach of the builders who acknowledged the interdependence of human beings, buildings and physical environment [3].

Bioclimatism is a concept that integrates the micro-climate and architecture with human thermal comfort conditions [4]. Different studies on vernacular architecture have revealed that bioclimatism is a critical parameter for achieving sustainability of modern architecture [5,6]. This concept takes into account the solar passive

techniques and micro-climatic conditions in building design, which improve the artificial energy efficiency of the building and thermal comfort conditions in the built environment [7].

Vernacular architecture is a term used to categorize methods of construction which use locally available resources to address the local needs [3]. These kinds of structure evolve over time to reflect the environmental, cultural and historical context in which they exist [3]. The building knowledge in this type of architecture is often transported by traditions and is thus more based on the knowledge achieved by trial and error and often handed down through the generations [8,9]. This kind of architecture is greatly influenced by culture and geographical location but the most fascinating aspect is that these architectures show identical architectural solutions in similar climates across totally different and very distant geographical locations [3]. This architecture is a source of great wealth for modern architecture as it represents solutions which show maximum adaptability and flexibility and thus sets an example towards sustainability. In modern times, building materials like cement, steel and bricks are highly energy intensive. Studies show that the embodied energy cost as well as running costs can be significantly reduced in climate-responsive building design [10]. Energy efficient building has the potential to reduce carbon emissions by 60% or more, which translates to 1.35 billion tonnes of carbon [5]. So climate responsive building design has become a necessity rather than an option for energy conservation and carbon emission reduction [5]. For sustainable solutions, environment and traditions are not supplementary to each other but are pre-requisites [7,11]. So we must not underestimate the solutions of vernacular architecture. Rather it demands a systematic and detailed scientific understanding [3].

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Solar energy utilized more efficiently by orientation of the building was found in Greece around 2500 years ago [5]. A few centuries later, Roman bathhouses were also built to receive maximum solar energy heat gain through south facing windows [5]. In India *Fatehpur Sikri*, *Agra* and *Red Fort*, Delhi are excellent examples of solar passive architectural concepts [12,13]. Different ancient civilizations have produced their own traditional architectural styles and adapted to local conditions. Gradually developed over ages and without the use of artificial energy producing devices, these buildings provided varying levels of comfort inside the built space [14]. In India there are exhibits of indigenous use of locally available materials and techniques to construct buildings that are based on the local climatic conditions or even on the ethnicity of the community [15–17].

Indian vernacular architecture includes informal and functional structures designed and built with local materials to meet the needs of the people in rural areas. These works also reflect the rich diversity of India's climate, locally available building materials, culture and ethnicity. Despite the diversity of the country, mainly three different kinds of architecture: *kachcha*, *pukka* and *semi-pukka* are available [9]. *Kachcha* building is made up of unprocessed natural material such as mud, cane, bamboo, thatch and wood

available in the vicinity. These kinds of buildings have specific form and the cost of construction is minimal. *Pukka* buildings are made up of stone, bricks, tiles, metal or other processed materials and *sirkhi* or mortar used for binding. These structures are expensive and do not require regular maintenance. *Semi-pukka* buildings are a combination of *kachcha* and *pukka* style. Common building materials in hilly areas are rocky rubble, ashlar, stone pieces, bamboo, wood and cane. In plain areas mud-blocks or sun-baked bricks are widely used for construction.

2. Different bioclimatic zones of north-east India

India possesses a large variety of climate ranging from extremely hot conditions in desert regions like Rajasthan to severe cold conditions at high altitude locations like Kashmir. Fig. 1 represents the existing bioclimatic classification of India. In this study we consider the north-east region of the country which consists of seven states; Assam, Meghalaya, Arunachal Pradesh, Nagaland, Manipur, Mizoram and Tripura. This region lies between 21°N to 30°N latitude and 89°40'E to 97°18'E longitudes. The north-east region is classified into three major bioclimatic zones: warm and humid, cool and humid, and cold and cloudy [18]. Fig. 2

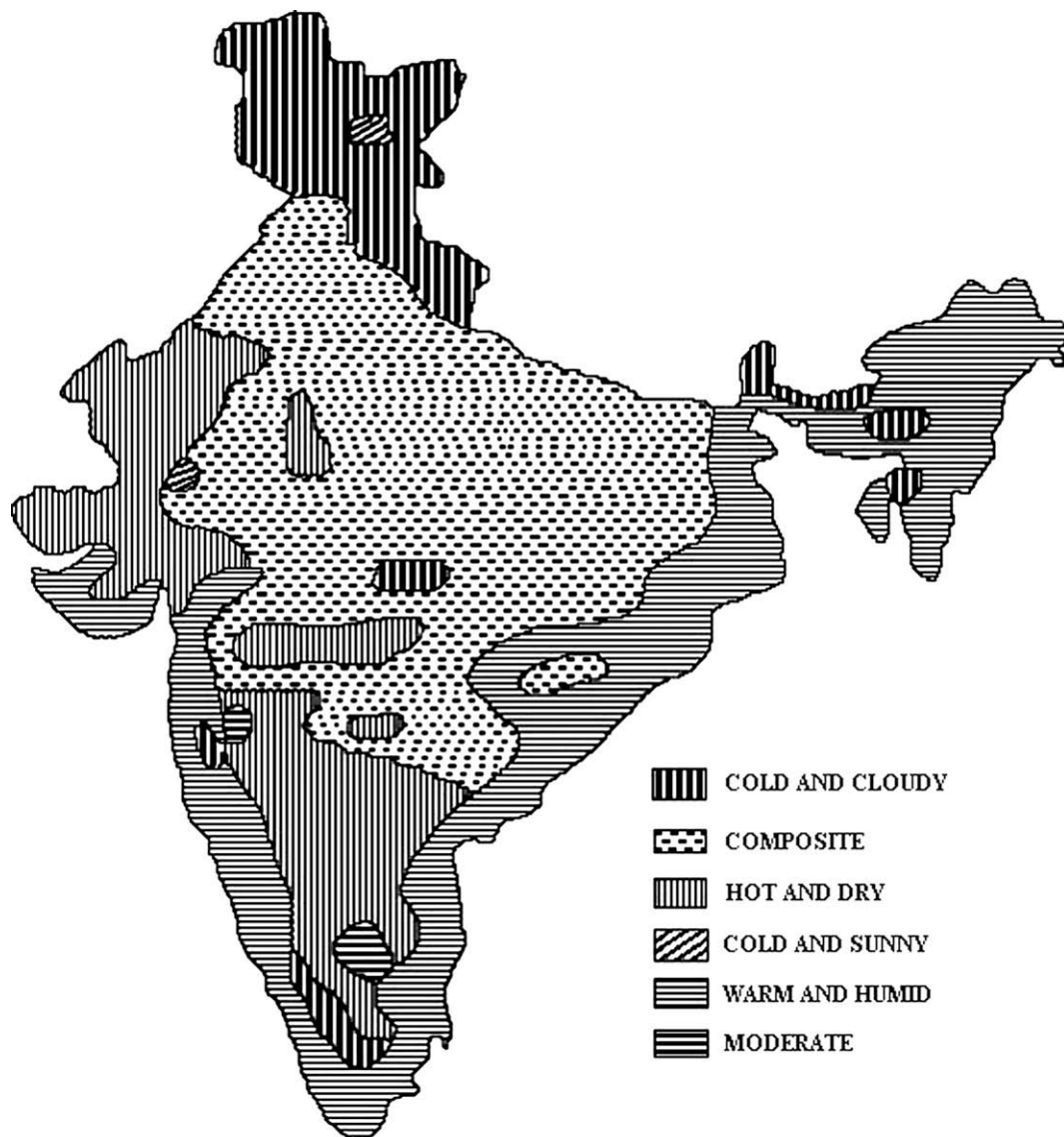


Fig. 1. Existing bioclimatic classification of India.

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