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Understanding the climate sensitive architecture of Marikal, a village in Telangana region in Andhra Pradesh, India

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ABSTRACT

Architecture and climate are engaged in a happy marriage in any indigenously developed settlement. We documented and analysed a vernacular settlement, Marikal in composite climatic region of A.P., as part of a large development project. Marikal's form and structure are a result of centuries of evolutionary process and knowledge transfer, reflecting a set of varying physical and nonphysical determinant forces such as climate and geology, religion, socio-cultural values, economics, technology and administrative factors. It is a closely knit fabric of small clusters of dwellings comprising of thick white walls, heavy roofs, small windows and narrow streets. Many house typologies are identified. The house plans essentially vary in size, shape and detailing, but not in their climate sensitivity. They are in great harmony with the occupation/activities of the occupant. The occupants adaptively synchronize their activities with the spatial environmental qualities of the space.

However, the 'house form' of Marikal is transforming due to social forces and the availability of electric controls in the recent decades. Once highly climate sensitive architecture and behavioural patterns are slowly getting metamorphosed into architecture and attitudes that are irreverent to climate and context. This study calls for a code of practice balancing modernization with the vernacular.

1. Introduction

Traditionally, our buildings are regarded as our third skin, clothing the second, while the biological skin is considered the first. These three skins help us maintain the deep body temperature at around 37 °C round the year in any geographical area. In the absence of precise temperature control measures, the role of the settlement/building design in mitigating the vagaries of wind and weather is extremely important in providing indoor comfort [1,2]. As a result architecture and climate are found to be engaged in a happy marriage in any indigenously developed settlement.

Understanding of the traditional architecture in terms of heat-humidity, air movement and light with respect to the physical environment provides vital lessons for the present design endeavours. The familiar elements of regional architectural styles (verandahs, balconies, courtyards, shutters and such) are created to use the sun for warmth and light and to create shade and breeze for cooling. Climatic design lessons can be learned and inspiration can be sought by observation of the long tradition of vernacular architecture [3–5]. These are important especially in the context of energy concerns from all around the world [6], and the alarming increase in air conditioning usage in the recent years [7].

Building energy consumption in India is the highest among all Asia Pacific Partnership countries [8]. With lax bye laws and growing pressure from various interest groups, more and more buildings in India are being designed in aluminum and glass, only to be air conditioned, least concerning about the climate or context. As a result, the buildings relinquish all their local character and wear the same skin be it in the desert of Rajasthan or in the hills of Himalayas.

On the other hand, the traditional houses of Telangana region are typical examples of buildings adapted to the composite climate. The aim of this paper is to evaluate the vernacular settlement of Marikal, in terms of its architectural typology and climate appropriateness of various features of the building and the settlement. This paper shows how a building environment working like living organism, which is inherently sustainable through the use of various bioclimatic concepts applied in its original construction, is tightly integrated with the living styles, landscape and has a little wastage of resources. The following analysis is comprised of two major parts: 1) a study concerning the evolution of the built environment (morphological development, site planning, cluster planning, construction materials and techniques); and 2) typological analysis of specific vernacular dwelling types and their response to climate,

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based on passive design principles that are responsible for the bioclimatic character of the settlement. The evaluation of the settlement and houses is carried out keeping in mind the environmental elements such as heat, humidity, air movement and light and the general activity pattern of the residents.

2. Marikal: a vernacular settlement in Telangana region in A.P.

2.1. Location and history

Marikal (N16°36′ and E77° 44′), a small village in Telangana region is in the south-western part of Ranga Reddy district in the state of Andhra Pradesh (A.P.) in India (Fig. 1a and b). It is about 120 km south-west of Hyderabad, the state capital and is 22 km from Mahboobnagar, a large town close by. It is located at about 5 km from 'Ananta Sagar' a large dry land reserve forest.

Anecdotal responses collected from the village elders of the Royal clan during the survey revealed that, Marikal has about 600 years of history. Both Muslim and Hindu feudal lords ruled Marikal till the abolition of privy purses. Remnants of the past can be traced in the walls of the mud fort at the center of the village and in the temples and *Dargahs* in its vicinity. The village has agriculture, aqua-culture and petty vending supporting its basic economy. It has over 2000 population (as per Census 2001) spread over an area of 0.2 km^2 of gently sloping terrain. It is not connected to any railway line or major highways. As it is an interior village, the original character of the village is less disturbed by urbanization or overt commercialization of land.

2.2. Data collection

The present analysis is based on the data collected during a development study conducted by the author in this village during 2006–2008. This study involved in depth data collection at various levels. The collected data is the outcome of an exhaustive household survey and field work of the author, assisted by a team of students of architecture. We have measured, sketched, observed, photographed, video-graphed buildings and interviewed inhabitants, local designers as well as public officers concerned with the village. In addition, we commissioned a professional surveyor to prepare the detailed village plan, as the village level detailed maps are not available with the government. However, the large scale topo-sheets of the region are procured from the Survey of India. This study is presented in the form of a documentary film [9], as part of the large development project.

2.3. Climatic data

The Meteorological Department provided the climatic data of Mahboobnagar, as it is the nearest meteorological recording station to Marikal. It has inland composite climate with four distinct seasons: Winter, summer monsoon and post monsoon. This region has hot-arid summers and slightly cool winters, and moderate to light rainfall (Fig. 2). Air temperature reaches a mean maximum of 40 °C and a mean minimum of 27 °C in May with a very high diurnal range (12–15 K). The summer months have an average temperature of 31.3 °C, while the winter months have 25.3 °C. The annual mean temperature is about 27.6 °C and the relative humidity varies from 29% to 83%, while the rainfall totals 810 mm in a year.

2.3.1. Physiological objectives

Summer in Marikal is usually hot and dry (mean temperature (T_o) = 31.3 °C, mean RH = 39.3%), with the period of greatest discomfort being April to May, as the Humphreys' comfort temperature [10] (T_c)[1] exceeds the outdoor mean temperature (T_o) substantially (Fig. 2). Protection from conductive and radiant heat gain is thus necessary to avoid physiological discomfort in summer. Observable, the structure and built form of Marikal aptly respond to this hot-dry season.

In the other months, especially in June and in winter, physiological discomfort is mitigated through clothing/activity adjustments and increased ventilation through the use of various controls. Monsoon months are usually warm-humid (T_o = 27.5 °C, mean RH = 72.4%), with a mean monthly rainfall of 150 mm received from the southwest monsoon. Physiological discomfort due to heat is not a major problem in this season as the temperature is below the skin temperature. This period is followed by north-west monsoon which receives very light spells. Winters are salubrious although with moderate to low humidity.

2.4. Evaluation using Mahoney's tables – recommendations

The climatic data are analysed using the Mahoney tables which provide preliminary design recommendations. They are grouped under eight headings: layout, spacing, air movement, openings, walls, roofs, outdoor sleeping and rain protection [11]. Recommended specifications for Marikal are as under: 1) Layout: buildings oriented on North and South (long axis east-west) to reduce sun exposure, with compact courtyard planning; 2) Spacing: compact planning with protection from hot and cold wind; 3) Air movement: rooms double-banked with temporary means for air movement; 4) Openings: very small openings, 10–20% of wall area; 5) Walls: heavy external and internal walls; 6) Roofs: heavy roofs over 8 h time lag; 7) Outdoor sleeping: space for outdoor sleeping required; 8) Rain protection: rain protection not required.

Intriguing, the present settlement is found to be in complete agreement with Mahoney's recommendations in all these aspects mentioned above. A detailed analysis of its climate appropriateness is presented below.

3. Climate appropriateness of the settlement

3.1. Landform and topography

Marikal is surrounded by about 15 natural lakes within a radius of 3 km, all interconnected through natural flow of gravity. As this is a dry region with a little rainfall, the water table is usually very low and the lakes are the prime source of water for human habitation, agriculture and aqua-culture. The early settlers exploited the contour and slope of the landform to the fullest [2]. They established the village fort and the surrounding settlement at the center of a shallow bowl shaped trough, formed by the local topography. It is interesting to note that the lake next to the fort is at the lowest contour, enabling it to retain water even during prolonged droughts (see Fig. 3). Sadly, most of the lakes have dried now, excepting three large ones, due to poor maintenance.

Establishing the village at the bottom of a shallow trough has other advantages in addition to having the highest water table for the village inhabitants even in summer. As the country side is barren, summer breezes are usually hot and add to the discomfort. Understandable, the settlement, thus developed at the bottom of the shallow valley retains the cold mass of air and remains protected from hot breezes. The village has a gently sloping terrain, towards lakes in the south-east and has huge masses of natural rock out crop towards the north-west (at a distance of 2 km).

[1] $T_c = 0.514\,T_o + 13.5$.