

The Local Climate Adapting Characteristics of Traditional Buildings in Indochina- Sustainable Designs from Vernacular Architecture

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Abstract

At the beginning of the 21st century, sustainable development began and became the operating platform for all countries worldwide. Since then, sustainable architecture has also appeared with its characteristics and principles to minimize the impact of architectural activities on the natural environment, bringing significant benefits to society. However, the architecture problem for sustainable development has appeared for a long time, typically in three Indochina countries: Vietnam, Laos, and Cambodia. Before becoming a French colony and being enlightened, people relied on nature to build very comfortable residences without exploiting excessive energy to cause consequences such as the destruction of resources, ecological imbalance, and climate change. All of the above are handled wisely by the local people. This article aims to learn about the architectural solutions that the indigenous people use to help adapt to the local climate when they do not have the concept of energy sources, but that is the beginning of sustainable development architecture in Indochina.

Keywords: Sustainable, Indochina, traditional architecture, local climate, vernacular architecture, solutions.

1. Introduction

Indochina is a land belonging to the East, with natural conditions in the East quite favourable, with favourable rain and wind, large river basins rich in alluvium, fertile, hot and warm climate, so the ancient civilization of the East Winter was formed on agriculture. The earliest was the slave state in Mesopotamia (4th century BC), then came the states in the Indus, Ganges and Yellow River, and Yangtze rivers (3rd century BC). . The architectural works in the East are mainly religious temples. Construction materials are mainly bricks and mud mixed with convex straw. Convex bricks are made from clay in Mesopotamia, then fired or dried in the sunlight, using the mud to make a binding mortar.

Traditional Eastern architecture is primarily influenced by the architectural style of China, the oldest civilization in East Asia. Traditional oriental architectural works often use wood as the primary material to build the load-bearing structure for the building and use the weight from the roof of the building to create stability. In each country and each period, the architectural style has specific changes. In the modern era, Eastern architecture has used less

wood and imported many influences from Western architecture and modern architectural styles worldwide for daily use. However, countries such as China and Japan still retain a lot of distinctive architectural works with traditional Asian styles.

Hot and humid tropical countries such as Vietnam, Laos and Cambodia have the following characteristics: high temperature, full sunshine, lots of rain, high humidity, a slight temperature difference between day and night, and surrounded by green, clear sky. To suit that climate, the buildings are often stretched, sticking to the ground or leaving the first floor empty, creating light ventilation, with low and long windows to catch the wind, limiting sunlight, and having a roof stretched out to resist the pouring rain. Interspersed with the work are yards, gardens, and lawns to take advantage of shade, improve the climate and create beautiful landscapes. The architecture often integrates and hides in the greenery, treated with open space and circulation with flexible movable doors. Even within a country, in an area, the natural climate conditions are also different due to topographical characteristics, so the architecture also has different solutions, but all have the idea of sustainable development architecture.

2. Effects of natural conditions on traditional architecture in Vietnam and popular solutions

Vietnam is a long and narrow territory on the Indochina peninsula, one of the countries of Southeast Asia and located along the Pacific coast. The North, the West, and the East are bordered by China, Laos-Cambodia, and the East Sea. Nearly half of the country's area is mountainous and highland, spreading across the North and West of the country, running in the direction of Northwest-Southeast in an arc. Besides the majestic mountains, Vietnam also has extensive plains, accounting for $\frac{1}{4}$ of the country's area, in which the delta accounts for more than the terraced fields of the mountains. The three delta regions from North to South are mainly located in the North, Central and South.

For Vietnam, because it is located close to the East Sea area, the nature of the climate is also profoundly influenced by the sea. In addition, because it is located in the tropical belt, the annual temperature is high, and the humidity is relatively high. The territory of Vietnam can be divided into two distinct climate zones:

The South Central Coast and the South: have a tropical climate due to less influence of the monsoon, divided into two seasons: dry season and rainy season. The climate is hot all year round, and humidity and wind speed are not high.

The North and the Northeast of the North: is a place with a different climate that is different from the South and the other two neighbouring countries. Northern Vietnam also has a tropical monsoon climate but is influenced by the Northeast monsoon (blowing from the Asian continent) and the Southeast monsoon with high humidity. The climate in the North is divided into four distinct seasons (spring-summer-autumn-winter), the winter is cold and wet due to the monsoon blowing from the North, and the summer is hot due to the rapid increase in humidity. The irregularity of the seasonal rhythms of the climate, river flows and the high weather volatility are significant obstacles to the region. [14]

Northern of Vietnam:

The villages of the Northern Delta are often covered with green bamboo groves. Behind the green bamboo groves will be the traditional houses of the Northern Delta.

The architecture of these traditional houses is quite similar. Usually, there is only one floor; the floor is close to the ground, and the primary materials are straw and bamboo. The house's structure will start from the entrance gate, through a garden, into the large courtyard,

then to the main house, outbuildings, kitchen, toilet area, cattle barn, buffalo and garden. Behind the front pond, the fence is surrounded by trees; the outside is surrounded by bamboo ramparts of the village... creating an ecological model of a garden - a pond - a closed barn.

The people's houses in the Northern Delta constantly adapt to the environment when built, creating a sustainable ecosystem because they know how to rely on nature as living spaces often gather in one block, only separated by a wall to separate the central area and the sub-zone. The house is made with a structure of three compartments and two wings, without partitions to help the house be ventilated in the summer and warm in the winter; This is different from the style of subdividing indoor spaces like Western architecture. In addition, because it is close to the sea and is located in an area affected by the tropical monsoon climate, traditional houses are often built in the South to catch the strong winds in the hot season but avoid the afternoon sun from the west. Cold winds come from the North or northeast monsoon, and storms come from the east. The wall of the house faces east and west.

In order to drain rainwater and avoid leaking, the roof of the house is usually a roof with a significant slope from the space under that roof; it can be made into a mezzanine, a mezzanine shelf to store food. In addition, to prevent rain from hitting the wooden pillars and clay walls and at the same time create shade, the roof is often moved away from the base of the wall, thereby creating a large porch around the house to help shade the sun straight into the house. Roofing material can be tile, leaves, straw or thatch. If it is a tile roof, there will be two layers, one on top of the other, thanks to the air layer in the middle, so the insulation is excellent.

The wall surrounding the house is very thick with earth or brick, so it also provides insulation for the house. In order to regulate the climate for the interior space of the house, the walls often have decorative solutions in combination with window boxes, whitewashed walls or leave the colour of materials such as unpainted brick walls, but only The circuit reduces the heat of tile roofs and brickyards. Clay walls are thickened to keep them cool in the summer and warm in the winter.

In the traditional houses of the Northern Delta, trees are also used as a solution to adapt to the natural environment. In the past, people planted trees with large canopy and dense leaves like banana trees in the North to prevent the northeast wind in the cold season and at the same time prevent solar radiation in the summer; Plant tall trees such as areca and coconut trees in the South to catch the cool breeze in the summer and catch the sun to warm the house in the winter. Vines planted near the house, such as loofah, squash, and gourd... act as a natural shade, anti-glare and anti-glare due to reflections from light-coloured walls around the house [5], [3] (figure 1).

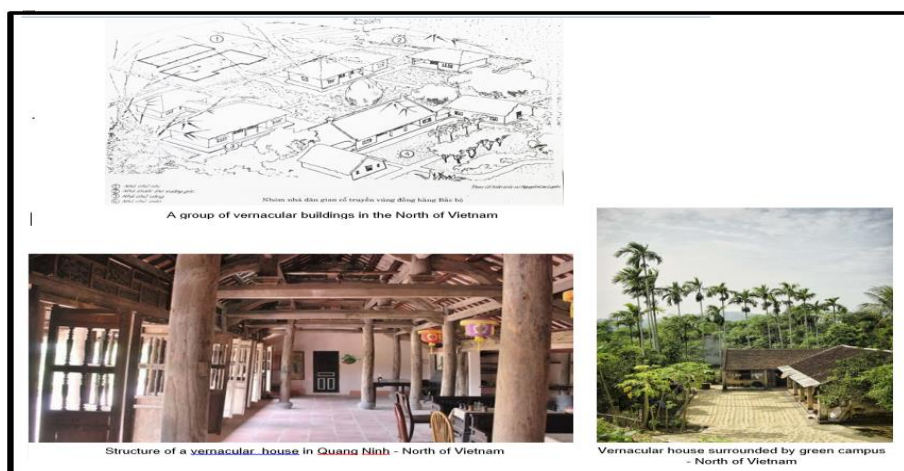


Fig. 1: Vernacular housing in the North of Vietnam

Middle of Vietnam:

This is an area located between the two regions, facing the sea and back leaning against the mountain, with the climate of both regions influenced by Lao wind and frequent storms, so the traditional architecture here can adapt to the harsh conditions of the climate, must be ventilated to prevent heat in summer and closed to prevent cold in winter.

The direction of house is built in a direction to avoid the disadvantages and dangers of nature. Doors do not open in the north, and avoid arranging doors in a straight line to avoid cold wind. Trees are used as an intimate thing for the residents of Central people to resist the harsh climate of the hot and dry climate of the lowland near the sea, often planted in front of the window to shade the sun, make cool the air and limit visibility from the outside.

The house has three compartments and two wings; the ground is almost square because the Central region has many big storms and strong winds, so that the square ground will be more stable.

The roof is low and heavy with a sturdy frame system to withstand prolonged storms; the large slope has a fast drainage effect, reaching out from the base of the wall 0.6m-0.8m to protect the wall, the foot of the column from rain and sun, prevent mould, moss. In addition, a relatively straightforward mark of the land with hot and humid natural conditions and frequent storms is that the roof usually accounts for more than half of the height of the house, partially covering the columns, creating a firm grip firmly on the ground. The roof is covered with double or double-hooked tiles; in the middle, there is a layer of lime to create adhesion and heat resistance for the house against wind storms and tropical depressions. The floor of the house is made of soil mixed with lime and ash and compacted in many layers to prevent mould.

Locally available building materials such as wood, stone, earth, ceramic, bamboo, rattan, etc., over time, become walls with many holes for ventilation, sun protection, moisture resistance, and colour of objects. This material is mainly kept the original with warm and warm colours and has low sunlight reflectivity and little heat, so even though the door is closed to avoid cold, wind, and heat, it is still not secretive. [3], [4] (Figure 2)



Fig. 2: Vernacular housing in the Middle of Vietnam

Southern of Vietnam:

The climate in the South is mild, with little rainfall. The traditional architecture in the South has similarities with the traditional architecture in the Central region; the scale is usually more significant than the traditional architecture in the North. Not paying much attention to the direction like traditional architecture in the North, in the South, it is often prioritized to approach traffic and then to the direction of calm wind blowing into the house [5, p. 35]; houses are usually built in the South and the south-east, and south-west directions are considered the best direction to catch the cool breezes from the sea and enjoy a good and stable light source.

The overall plan of the house has many folds with adjacent roofs; the main areas and the sub-zones of the house are often linked together into one block. The house is small gradually bowled, influenced by the Central region.

The roof is usually a double-sloping roof with gables; these roofs block rain and direct sunlight on the outside wall on the side of the house. The roof has a high slope for quick drainage. At the same time, the wall on the side of the house is also arranged with windows to get light, take the wind to make the interior space of the house naturally ventilated and have a cooler temperature; wooden walls create slots for wind and light. The house's interior space is quite spacious, with a tiled roof that looks from the outside like the house has a low height, but when stepping inside, the rafter, column and ceiling system are very high to insulate and insulate limit the heat View from the outside.

Most of the construction materials are available in the area, mainly made of wood, ceramic, terracotta, melaleuca, nipa leaves, etc. are wet and quick-drying materials, suitable for freshwater or brackish water environments. The above materials can be used to make walls, which is an excellent insulation material for the hot and humid climate of the South.

Due to the soft ground, traditional architecture in the Southern region has a compact structure, often using available materials adapted to the climate with two distinct of rain and hot seasons. Trees are planted around to keep the soil and create maximum shade to cool the house.

Thus, the way of dealing with natural factors clearly shows the adaptability of the Vietnamese people in making use of and responding to the happenings of nature, knowing how to take advantage of natural conditions in the construction of natural resources in Traditional architecture. Those are the experiences from many years of the Vietnamese creating the typical traditional architecture that can only be found in Vietnam [5]. (Figure 3)



Fig.3: Vernacular housing in the South of Vietnam

3. Effects of natural conditions on traditional architecture in Laos and popular solutions

Laos is a country with a jungle landscape consisting of rugged mountain ranges and several plains and plateaus. Laos has a tropical climate, influenced by the monsoon; it is a landlocked country with no sea border on any side, which is also why Laos' climate is dry. The rainy season is separate and lasts from May to November, followed by a dry season from December to April. According to local tradition, a year has three seasons: the rainy, cold, and hot seasons, the last two months of the dry season are significantly hotter than the previous four months. [15]

The Indigenous culture and lifestyle of local people have greatly influenced the architectural design here, creating a unique architecture. The traditional architecture of Laos mainly exists in two typical types: residential and religious buildings [11]. Specifically, before becoming a French colony in 1983, the Laotian town consisted of only super crooked stilt houses made of wood or bamboo, with a characteristic thatched roof (Figure 4). These traditional stilt houses are a fascinating cultural heritage, powerfully demonstrating the Lao people's sense of community and religious beliefs. In addition, the architectural style of these traditional stilt houses reflects the will to face challenges in hot, humid and harsh climates [1]. The houses will have a front porch and raised due to heavy annual floods to keep out predators while creating a space underneath that makes the floor cooler in the middle days when the weather is scorching; This is necessary because villages in Laos are often located near rivers when the ground is dry, the lower part of the house on stilts will be used for handicraft production or cattle-rearing. In addition to sleeping time, all family activities take place outside in the summer, on the porch [8].



Fig.4: Stilt houses in Laos

The materials of traditional houses in Laos are usually made from wood and built in one day. Besides, many houses on stilts are built with bamboo - a material that is quite easy to find in the natural environment and easy to construct (Figure 5). The area below the house on stilts will be used to store utensils and goods, as a cool place to relax, prevent heat during the day, or be used to raise livestock. Materials of the building structure such as frames, floors, columns, and walls are all made of wood. The floor will be about three meters from the ground, and the stairs to get up and down the house will be 1.2 meters wide. Patios and columns are often decorated with unique patterns of the Lao ethnic group and are often made of wood. The old wooden house on stilts has a concave roof, the curved shape of the roof is made of a curved plank called a gable cover placed at the edge of the gable to keep the roof tiles or thatched roof layers from being blown up by the wind. [9][10].



Fig.5: *Bamboo Stilt house in Laos*

In addition, besides these stilt houses, there exists a traditional Lao-style house which is also very unique. This type of house is usually built for the higher classes of Lao society, often found in the central areas of the community. It is a type of house with a double roof, with two peaks like two mountains; the main door opens at the gable side (different from the Vietnamese tile-roofed house, the main door usually opens at the side along the length of the roof), the roof slope is about 30-60 degrees to overcome heavy rainfall, and the roof also protrudes outward to protect doors, windows and partitions from rain and sun. Roof materials are made from thatch, bamboo, wood, and clay (terracotta) of local origin, capable of generating low heat and preventing direct solar radiation from entering the interior functional spaces. The roof will be covered with a thick layer of materials from leaves to insulate and cool the temperature inside the house, natural ventilation to reduce humidity and facilitate air circulation inside the interior spaces. The roof fringes are decorated with arrow-shaped wooden motifs alternating up and down, often facing north and south to avoid rain and hot wind [9] (figure 6). These features mean that the homes are in harmony with the natural environment.



Fig. 6: *Grass thatch roof of stilt houses in Laos*

3. Effects of natural conditions on traditional architecture in Cambodia and popular solutions

Cambodia is located in the southwestern part of the Indochinese peninsula, bordering Thailand to the west and northwest, Vietnam to the east, Laos to the northeast, and the sea to the south. Cambodia has a tropical monsoon climate with one side bordering the sea. The weather here is quite hot and humid, with an average temperature of about 27-30 degrees. The seasons in Cambodia can be divided into two main seasons: the rainy and dry seasons, which last for a relatively equal period of time. In summer, the air from the southwest monsoon is filled with water vapour that blows from the Indian Ocean. The airflow will reverse in winter, and the northeast monsoon brings dry air. The southwest monsoon lasts from mid-May to mid-September or early October, and the northeast monsoon lasts from November to March. The southern third of the country has a dry season lasting 2- 3 months; two-thirds in the north have four months of the dry season; January is the coolest month, and April is the warmest month.

In addition, because the high mountains block the wind from the sea, Cambodia's climate is drier. Cambodia has a considerable amount of rain, but due to the topography, most water flows directly to the sea; only a tiny part flows into the rivers flowing in the basin. Humidity at night is relatively high throughout the year; it often exceeds 90%. During the daytime in the dry season, the average humidity is only about 50% or less but rises to 60% in the rainy season.

Characteristic in the traditional architecture of Cambodia is the house on stilts; like in Laos, the house on stilts is an integral part of the culture of the Kmer people. The houses on stilts are located on wooden pillars over 3m high. Cambodia formed a lifestyle of houses on stilts because it is located in the lower reaches of the Mekong River, so in the flood season, water from Tibet pours in and engulfs most of this country. In Tonle Sap, it is measured that compared to the water level at the end of the dry season, the flood peak can rise to 15 m, so the custom of living on stilts is to avoid floods. Second, from ancient times until now, Cambodia has had a lot of wild animals and poisonous snakes. In the past, in the season of crocodiles from the lake, the primeval forest gave rise to many plains.

Along with crocodiles, tigers are also a threat. Especially Cambodia has a lot of poisonous snakes. Khmer people worship snakes but are very afraid of snakes. During the flood season, the snake has no place to live and has to crawl up to the people's places. So Cambodians build square stake houses to avoid snakes crawling up and crocodiles and other wild animals. The last reason is that the house on stilts is still helpful in terms of business and weather in Cambodia. Farmers here raise cattle a lot; they do not need to build a barn; when the afternoon comes, they drive the buffalo to the pole for it to lie in a spacious, cool space on the floor. That space is also where farmers cook and stretch out hammocks for lunch.

The roof is covered chiefly with dragon scale tiles. Poor houses with thatch or jaggery leaves...have excellent insulation and heat resistance. The roof has a triangular shape; like a traditional Vietnamese house, there are houses with six roofs, and there are houses with eight roofs, running evenly from front to back, with excellent drainage [7] (Figure 7).



Fig.7: Vernacular houses in Cambodia

5. Conclusion

As the amount of waste from the construction industry is a burden on the environment, looking back on the past has given us many ideas about the issues related to sustainable architecture. From materials, and structures to culture, aesthetics... All are the foundation to form new directions for sustainable architecture in the future when the world is increasingly interested in the issue of the environment. Case studies from 3 countries in Indochina, namely Laos, Vietnam and Cambodia, will help us apply traditional knowledge in architecture to create sustainable architectural buildings while at the same time continuing the local identity to spread the local culture, which in turn can inspire the next generation in sustainable architecture in Indochina.

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