ONLINE ISSN 2069-7430
ISSN-L 1841-4737
PRO LIGNO
www.proligno.ro
Vol. 18 N° 4 2022
pp. 45-56

OLD STILT HOUSES AS AN INSPIRATION FOR MODERN DWELLINGS

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Abstract:
Stilt houses, also called pile dwellings, lake dwellings or palaphites are houses built on raised platforms. They can be built in a variety of locations, but are predominantly found in countries with tropical climates. This type of house is built primarily as protection against floods, but also as protection against wild beasts or enemies. The shaded space under the house can be used as a work space or as storage. Thus, they are usually built over water, but can also be built on sand or dry land. The materials used to build a house with stilts are wood, stone, and sometimes even mud, depending on the region where the house is located. In many places, stilt houses can be found in the countryside, but commercial and modern variations of these houses are also popular. Stilt houses come in a wide variety of styles. Old stilt houses are made with natural materials collected from the surrounding areas to create a basic structure, while some new houses are built nowadays using sophisticated materials and construction techniques.
The aim of the paper is the analysis of wooden houses built on stilts from the perspective of two Asian cultures, as a source of inspiration for modern camping and glamping houses.

Key words: *stilt house; Thai house; Bahay Kubo; camping; glamping.*

GENERAL ASPECTS CONCERNING THE STILT HOUSES

Stilt houses, also called pile dwellings, lake dwellings or palaphites are houses built on raised platforms. They can be built in a variety of locations, but are predominantly found in countries with tropical climates. This type of house is built primarily as protection against floods, but also as protection against wild beasts or enemies. The shaded space under the house can be used as a work space or as storage. Thus, they are usually built over water, but can also be built on sand or dry land.

The stilts in Europe date back to prehistoric times in the 5th-1st millennium BC, especially in the Alps, and in Scandinavia, but also in the Po Valley, where they were found under the name Terramare. Today, stilt houses are very common along the coasts of Southeast Asia, in the Amazon and Africa, but can even be found in the United States and South America (https://cdn.dick-blick.com/lessonplans/stilt-houses/stilt-houses-stilt-houses.pdf).

The materials used to build a stilt house are cement, wood, stone, bamboo or sometimes even mud, depending on the region where the house is located. In many places, stilt houses can be found in the countryside, but commercial and modern variations of these houses are also popular.

Also, the traditional form of stilt houses in the region has evolved, retaining certain architectural features from the past, while other aspects have been renovated to suit new modern lifestyles.

Buildings that are raised above ground do not need extensive foundations. Conversely, although they are eligible for lower insurance premiums in most countries, this does not mean that flood insurance is not required. However, the costs are significantly lower than a house built at ground level.

"Stilt level" refers to the height from the ground of a building, which consists of the structural columns that support such a dwelling (https://www.propertygeek.in/stilt-houses/).

Stilt homes come nowadays in a wide variety of styles. Some are built using sophisticated materials and construction techniques, while others are made with natural materials collected from the surrounding areas to create a basic structure.

The purpose of the paper is the analysis of wooden houses built on stilts from the perspective of two Asian cultures, Thailand and the Philippines, as a source of inspiration for modern camping and glamping houses.

The various advantages of stilt houses are:

- More airflow in hot climates. As well as increasing the airflow under the floor.
- Dry space under the house in rainy seasons. People can use this space for storing goods, keeping and caring for animals, hanging things and other useful activities.
- Protection from animals and privacy from other people.

- Gives a visual advantage to people for hunting and also they can be used for military objectives.
- Can be built on hilly and uneven land and can also be built on flood-prone areas.
- The height at which stilt houses are built protects people from flooding.
- This type of construction allows people and communities to live and thrive in areas that have very little dry land available.
- Stilt houses are considered environmentally friendly because they can be easily built without causing significant damage to the landscape.
- The resistance over time is the same as that of traditional construction, wood can withstand pressures 5 times greater than concrete.

SHORT HISTORY OF STILT HOUSES

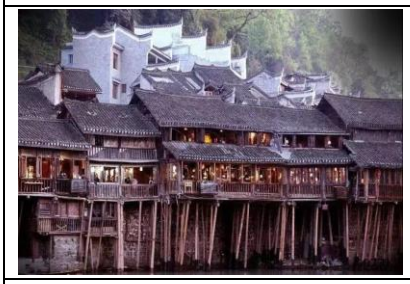
Piled houses, in the Neolithic and Bronze Age, were common in Italy mainly in the Alpine region and the Po valley. Some ruins have also been found around marshes in Slovenia and around lakes Mondsee and Attersee in Austria. There was a chance discovery in 1854 of a prehistoric lake village on Lake Zurich; nowadays is called the lake-dwellings phenomenon. More than 100 years of research have transformed this phenomenon into one of the most reliable sources of information in wetland areas archaeology (Menotti 2004).

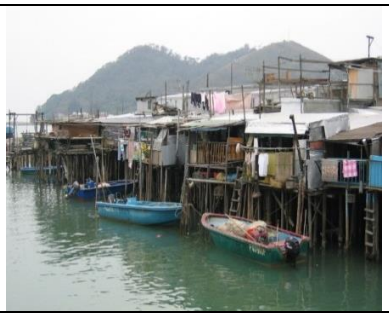
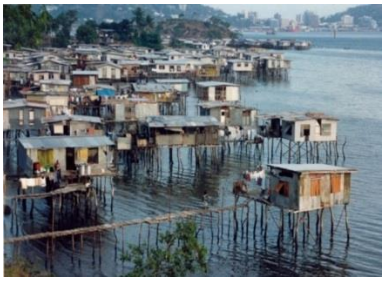
According to archaeological evidence, pillars were an architectural norm in the Caroline Islands and Micronesia and are still present today in Oceania. Today, they are still common in parts of the Mosquito Coast of northeastern Nicaragua, northern Brazil, southeastern Asia, New Guinea, and West Africa. In the Alps, similar buildings, known as Raccards, are still in use as simple granaries. In England, granaries are set on stones that are very similar to pillars and are raised above the ground to prevent mice and rats from getting to the grain (Menotti 2004).

Stilt structures are common worldwide. Some examples are given in Table 1, except the houses in Thailand and the Philippines, under study in this work. Over time they transformed, for example, the use of larger and more robust poles, the use of new construction techniques (more efficient and durable) and in some cases, they were moved from the water to the lakeside. Despite their advantages, a few drawbacks appear, such as the constant need to change the wooden posts that support the houses - the posts rot over time due to water. Also, the marshy bottom of the lakes causes other problems because the poles are not able to settle well on the ground (https://koaha.org/wiki/Palafitte).

Table 1

Examples of stilt houses worldwide (Fekete-Kaszoni 2022)

Name and region		
		
Diaojiaolou	Kelong	Raccard
South of China	Malaysia, Indonesia	Spain, Italy, Portugal
		
Pile dwellings	Malay house	Sang Ghar
Alps	Malaysia	Assam, India

		
Palafito	Pang Uk	Stilt houses
Chile	Hong Kong	Papua New Guinea

THAI STILT HOUSES

Thai people are mainly settled in the valleys near the waterways which are suitable for the cultivation of wet rice and flax (Fig. 1). Thai culture and lifestyle have developed over time and are still preserved.

Thai people's motivation for choosing houses on stilts:

- In the high mountains, they build houses on stilts to protect themselves from harsh weather and to avoid wild animals.
- Also, to avoid the annual flooding of the Chao Phraya River basin.
- To provide views of the vast rice fields.

Fig. 1.
Houses along the river.
(https://vovworld.vn/en-US/colorful-vietnamvietnams-54-ethnic-groups/thai-stilt-house-culture-678163.vov)

Traditional Thai houses are mainly built of teak wood (Tectona grandis), rubber wood (*Hevea brasilensis*) or other hard woods, even rosewood. Thai people build wooden houses without nails. The wooden beams and posts are tied together using bamboo and rattan (Nithi and Brian 2012). Cuts are used to fit the wooden elements into the joint, making it a "prefabricated house". This technique makes a structure strong and flexible, especially when the wood swells or shrinks in response to moisture or temperature changes. The "prefab" parts of a traditional Thai house can be easily disassembled and rebuilt. In the past people packed up their houses and moved with them.

THAI HOUSE STRUCTURE

Houses in each region of Thailand have their specific style, which reflects the lifestyle of the people, including social and cultural beliefs or religious customs and occupations. The stilt house structure in the central region, mainly near rivers, is the most common and simplest. The typical wooden house in central Thailand is characterized by a certain elegance. It has a curved roof, the concave edge of the pediment ends in a snake shape, and the walls are trapezoidal (Fig. 2). Structurally, traditional houses are less compact than today's residences. Access to the individual rooms is preferred through a large open-air platform - porch - called a chān. The veranda is often a significant part of the house, sometimes occupying up to 60% of the house area. This allows a maximum flow of air and natural light into each room (Tantasavasdi et al. 2001).

A poor family may start with one building and a terrace and use a small covered area at the side as a kitchen. As the family grows, it can add two buildings or five. An even number of buildings brings bad luck. When the soil is dry, families use the sheltered area under the house, which is about 2m to 2.5m high, to work on crafts, store tools, or raise chickens and ducks (http://www.pattaya-location-beach-front.com/anmaison.php). The structure and materials used to build a traditional Thai house are displayed in Table 2.

Fig. 2.
Typical wooden house in central Thailand.
(https://www.orientalarchitecture.com/sid/640/thailand/other-statewide/thai-houses)

Table 2

Structure and materials of Thai houses

Elements and materials		
Structural elements	Walls	Roof
• Teak wood	• Bamboo fibres	• Straw
• Rubber wood	• Palm leaves	• Vine

Some constructive details used for recreation houses in Thailand are given in Fig. 3, Fig. 4a, b.

Fig. 3.
Thai houses for recreation.
(Fekete-Kaszoni 2022)

a. ***b.***

Fig. 4.
Details of Thai houses for recreation *(Fekete-Kaszoni 2022)*
a-the roof; b-the window.

THE EVOLUTION TOWARDS MODERN HOUSES IN THAILAND

Most of the domestic wood supply comes from plantation species: this includes woody species such as teak and eucalyptus, but also wood obtained as a by-product of agricultural processes, such as mango and durian wood. By far, the largest volume of this type of wood is represented by rubber wood even today. However, almost all current buildings in Thailand are reinforced concrete post-and-beam construction; the clay tile roof is preferred (https://www.orientalarchitecture.com/sid/640/thailand/other-statewide/thai-houses). An example is given in Fig.5.

a. ***b.***

Fig. 5.
Old and modern Thai houses (Nanta 2009)
a-old Thai house; b- modern Thai house.

Currently, the Thai wooden house is considered a cultural and historical monument. In an era dominated by concrete apartment blocks, the old style has been reintroduced for tourism, albeit slightly modernized. The Thai government and community are now interested in the preservation and development of these monuments (http://www.hms.civil.uminho.pt/sahc/2006/0367.pdf).

STILT HOUSES IN PHILIPPINES - BAHAY KUBO TYPE

Bahay Kubo is a symbol of Filipino culture, it is a local version of vernacular architecture (Levy 2021). The name of the primitive hut is based on the Spanish expression *Cubo*, which means cube, probably because of its rectangular appearance, and *Bahay* is the Filipino word for house (Lico 2008). Such a construction is shown in Fig. 6.

Filipinos' motivation for choosing houses on stilts:

- provide residents with safe shelter from wild animals and snakes
- protection against torrential rains and floods
- superstitious reasons.

Fig. 6.
Bahay Kubo house in the forest.
(https://delishably.com/vegetable-dishes/Vegetables-On-Philippine-Folk-Song-Bahay-Kubo-Nipa-Hut)

STRUCTURE OF THE FILIPINO HOUSE

Bahay Kubos are built on stilts and the access to the living area is by a ladder (*hagdan*). The ladder can be easily disconnected at night and placed on the terrace.

The house is naturally divided into three zones (Fig. 7):

- the middle living area, used for ventilation and as a food storage space or sometimes as a shelter for small animals (goats, birds), called *bulwagan*. It usually has no room dividers, being a multifunctional space.
- the area below (called *Silong* in Tagalog),
- and the space under the roof (*bubungan*), which may or may not be separated from the living area by a ceiling (*atip*) (https://en.wikipedia.org/wiki/Bahay_kubo)

The roof of the house is high and pitched, with an open gable, to permit fumigation; it is provided with wide canopies to provide shade from the hot sun and to stop the rain from reaching the space.
Some houses are also equipped with an open back porch or side porch, used as storage for water jars that can contain any combination of cooking and washing area, or bathroom; the cellar used for most household chores and also a solid or an alcove for storing carpets and pillows (https://en.wikipedia.org/wiki/Bahay_kubo).

The typical Bahay Kubo is raised with thick bamboo poles one to two meters above the ground, depending on the area where it is built. They are modular and have pre-built walls then attached to wooden piers. Lightweight materials make the Bahay Kubo easily to be moved from one place to another whenever needed (https://pdfcoffee.com/bahay-kubo-6-pdf-free.html).

The Bahay Kubo house is completely built with local materials as shown in Table 3 and Fig. 8.

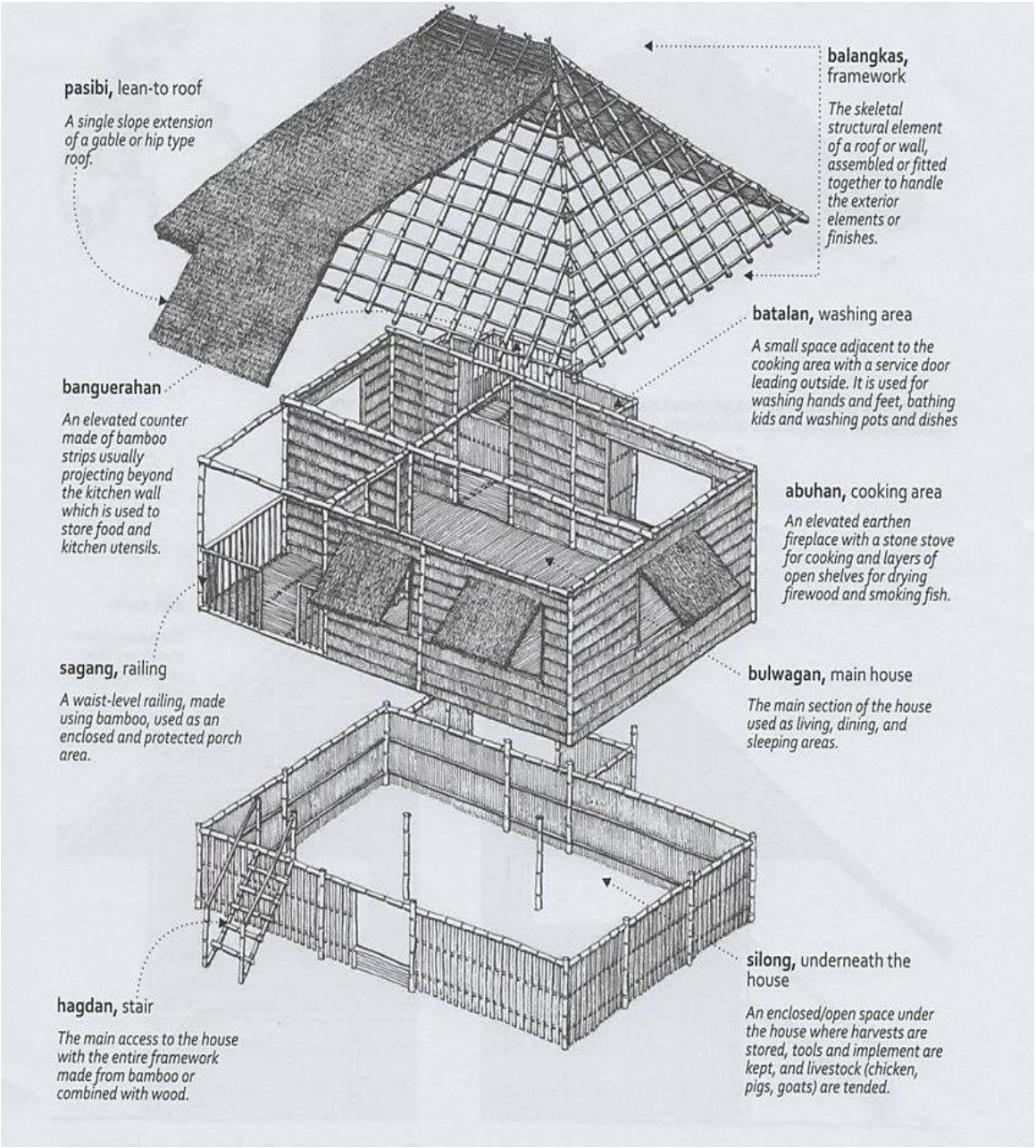


Fig. 7.
Components of a traditional Bahay Kubo house.
(https://www.reddit.com/r/Philippines/comments/lf1870/bahay_kubo_pre_colonial_filipino_houses/)

Table 3

Structure and materials of Bahay Kubo houses

Elements and materials		
Structural elements	Walls	Roof
• Bamboo wood	• Bamboo lamellas	• Bamboo strips
	• Nipa leaves	

Fig. 8.
Bahay Kubo house made of local materials.
(https://www.thefilipinorambler.com/2011/06/bahay-kubo-nosebleed-version.html)

Fig. 9.
Redonda House.
(https://en.wikipedia.org/wiki/Bahay_kubo)

Casa Redonda (Fig. 9) is one of the five nipa houses built by the Philippine national hero José Rizal, today a cultural heritage property. Like the construction (Fig. 10), the moving of the house (Fig. 11) is done by the members of the community. The *Bayanihan* tradition is practiced when people want to move to the countryside, mainly to avoid impending floods or landslides.

Fig. 10.
Bamboo structure.
(https://www.thethirdpole.net/en/climate/stilt-houses-assam-help-people-withstand-floods/)

Fig. 11.
"Bayanihan" practice by the community people.
(https://en.wikipedia.org/wiki/Bahay_kubo)

The Evolution Towards Modern Bahay Kubo Houses

In many places, the traditional Bahay Kubo is being replaced by modern structures but some of the original ones can still be found scattered in rural areas (Fig. 12). Nowadays, the traditional house is very popular in holiday resorts. Some modern Bahay Kubos combine traditional and modern materials.

The structure of the house in Fig. 12b follows the tradition of pillars and bamboo but uses a more solid foundation of cement and steel.

a. ***b.***

Fig. 12.
Old and modern Bahay Kubo houses
(https://www.spaceencounters.net/portfolio/modern-bahay-kubo/)
a-old Bahay Kubo house; b-modern Bahay Kubo house.

While most houses are still raised on stilts to avoid flooding and allow for maximum air circulation, few or none of today's Filipino houses are designed to be transported from one location to another. However, the traditional Bahay Kubo still influences contemporary architecture.

The once idyllic home has stood the test of time and nature as it is fully adapted to the sometimes dangerous environment of the country. This home reflects the Filipino identity, is considered an architectural and monumental masterpiece, a national symbol, a cultural heritage and a sign of unity. Although the shape

and dimensions have changed over the years, what has remained is the desire to have a collective space in an authentic Filipino style and feeling.

GENERALITIES REGARDING THE MODERN STILT HOUSES

Asian vernacular houses can give various design hints to modern houses (Kubota et al. 2018).

Having as a source of inspiration the stilt houses from Asia, CASArbor Company in Romania produces houses on wooden stilts mainly for camping and glamping abroad (Fig. 13). Glamping is a new form of tourism, a form of camping that involves more luxurious accommodation and facilities than those associated with traditional camping. Glam camping has become very popular in France and Belgium in recent years (Fekete-Kaszoni 2022).

France and Belgium are the main destinations for houses built by CASArbor. The company's ambition is to sell this type of cabins in Romania as well. The "new model" concept introduced in 2021 refers to the increasing of the thickness and insulation of the walls from 4cm to 10cm, to become habitable all year round even in Romania (Fekete-Kaszoni 2022).

Fig. 13.
The wooden house - Feroe Motel.
(Fekete-Kaszoni 2022)

USED MATERIALS

Class B softwood is used for the construction of houses:

- Treated pine (*Pinus silvestris*) is used for the exterior elements and aims to increase the durability and resistance of the wood to external factors (rain, snow, wind, sun, mold, pests, fungi). Thus treated, the wood is protected against the weather or the destructive action of UV radiation.
- Spruce (*Picea abies*) is used for the interior elements, as these elements do not have to face the same weather conditions as the exterior ones.

a.

b.

Fig. 14.
Wood impregnation (Fekete-Kaszoni 2022)
a-wood impregnation in autoclave; b-wood colour using Tanalith vs Tanatone.

Two solutions are used for wood impregnation (Fig.14):

1. Tanalith, a water-based solution that protects wood.
2. Tanatone, a color additive, responsible for the pleasant brown color.

The impregnation of the wood consists of a cycle involving decreasing, increasing and decreasing again the pressure. The duration of the impregnation process varies depending on the wood species, the thickness of the marks and the subsequent use. It should be noted that spruce wood does not lend itself to autoclave treatment, because the wood fiber does not absorb protective solutions. Because of this, only pine wood is used for the exterior elements.

The models of houses are complex and different, they have areas between 16-35 square meters, they are equipped with a terrace, bathroom, kitchen and 1, 2 or even 3 bedrooms (Fig.15). To maximize production efficiency and standardize the elements used in each house, the floor, wall and roof panels were designed to be modular.

a. ***b.*** ***c.***

Fig. 15.
Modern stilt houses produced by CASArbor (Fekete-Kaszoni 2022)
a-BoraBora wooden house, interior area 35m^2; b-Cape Town wooden house, interior area 27m^2; c-Solaro wooden house, interior area 16m^2.

CONCLUSIONS

Houses on stilts come in a variety of designs, and use of materials, from the perspective of a multitude of cultures. Many of them were adapted to the times in which they were built, while in some cases they were designed simply to meet the needs of the occupants. In all cases, however, they are combined with different styles and models. Traditional stilt houses are preserved as monuments and at the same time transformed, and modernized in the direction of tourism. Although in modern times wood is exported on a large scale, this paper has studied wooden structures that utilize local wood species.

Stilt houses, when improved according to the requirements of the current times, are extremely popular both in Western European campsites and in tropical areas, adapted to the local style and materials.

REFERENCES

Fekete-Kaszoni L (2022) Analysis of wooden structures from various cultures (in Romanian). Dissertation thesis, Transilvania University of Brasov, Romania.

Kubota T, Rijal HB, Takaguchi H (2018) Sustainable Houses and Living in the Hot-Humid Climates of Asia, Springer Nature Singapore Pte Ltd, https://doi.org/10.1007/978-981-10-8465-2

Levy LL (2021) The cultural groundwork for a Bahay Kubo model of eco-theology. QUEST: Studies on Religion & Culture in Asia 5.

Lico G (2008) Arkitekturang Filipino: A History of Architecture and Urbanism in the Philippines. University of the Philippines Press, Philippines.

Menotti F (2004) Living on the lake in prehistoric Europe: 150 years of lake-dwelling research. Psychology Press – London/New York Routledge.

Nanta, P (2009) Social Change and the Thai House: A Study of Transformation in the Traditional Dwelling of Central Thailand. Dissertation thesis, University of Michigan, USA.

Nithi S, Brian M (2012) Architecture of Thailand: a guide to traditional and contemporary forms. Singapore: Didier Millet, Singapore.

Tantasavasdi C, Srebric J, Chen Q (2001) Natural ventilation design for houses in Thailand. Energy and Buidings 33:815-824.

https://cdn.dick-blick.com/lessonplans/stilt-houses/stilt-houses-stilt-houses.pdf (accessed June 2022)

https://www.propertygeek.in/stilt-houses/(accessed June 2022)

https://koaha.org/wiki/Palafitte (accessed June 2022)

https://vovworld.vn/en-US/colorful-vietnamvietnams-54-ethnic-groups/thai-stilt-house-culture-678163.vov (accessed June 2022)

https://www.orientalarchitecture.com/sid/640/thailand/other-statewide/thai-houses (accessed June 2022)

http://www.pattaya-location-beach-front.com/anmaison.php (accessed June 2022)

http://www.hms.civil.uminho.pt/sahc/2006/0367.pdf (accessed June 2022)

https://delishably.com/vegetable-dishes/Vegetables-On-Philippine-Folk-Song-Bahay-Kubo-Nipa-Hut (accessed June 2022)

https://en.wikipedia.org/wiki/Bahay_kubo (accessed June 2022)

https://www.reddit.com/r/Philippines/comments/lf1870/bahay_kubo_pre_colonial_filipino_houses/ (accessed June 2022)

https://pdfcoffee.com/bahay-kubo-6-pdf-free.html (accessed June 2022)

https://www.thefilipinorambler.com/2011/06/bahay-kubo-nosebleed-version.html (accessed June 2022)

https://www.spaceencounters.net/portfolio/modern-bahay-kubo/ (accessed June 2022)

https://www.thethirdpole.net/en/climate/stilt-houses-assam-help-people-withstand-floods/ (accessed June 2022)