

# An Application of Eco-design Feature in Traditional Folk Housing to High-rise housing of Vietnam

Le Thi Hong Na\* and Jin-Ho Park\*\*

\* *Inha University, Department of Architecture  
Korea, hongna2311@yahoo.com*

\*\* *Inha University, Department of Architecture  
Korea, jinhopark@inha.ac.kr*

**Abstract:** This paper is concerned with the application of eco-features in Vietnamese traditional folk housing to high-rise housing. One of the main characteristics of vernacular houses is that they are designed with a deep understanding and respect for nature, but this design-with-nature approach is no longer found in the modern houses. The values of conventional dwelling must be considered and applied in the future eco-housing design process. Firstly, this paper introduces briefly about the climate and the environment in Northern Vietnam and their effects on traditional folk housing. Next, ecological elements are addressed by an architectural examination of the composition of the typical Vietnamese folk housing in relation to the local climate conditions and Vietnamese lifestyle. The result from actuality survey in Duong Lam, which is the oldest ancient village in Vietnam, are given. Finally, several models are proposed to apply the considered factors to high-rise housing design in urban Vietnam. The traditional Vietnamese house is an important source for the creation of a Vietnamese identity in architecture because it reflects and expresses the way of life of its users and was evolved by the Vietnamese over generations adapting to their needs, culture and environment.

**Keywords:** *Vietnamese traditional housing; tropical climate; passive design; urban high-rise housing; ecological architecture.*

## 1. Introduction

Along with the rapid development of industry, commerce, finance and the quick increase of population, the land resources became scarce. Therefore, the construction of apartments in Vietnam recently has a high-rise tendency. The demands of residents also become more diversified in accordance with economic growth and technological advances. Nevertheless, the size of residential apartment newly constructed does not meet the traditional characteristics of the Vietnamese lifestyle [4].

Many studies of Vietnamese authors emphasized on the characteristics of Vietnamese traditional housing, however there was not discuss how aspects of the traditional housing might be adapted for the high-rise and high-density living [9,5]. There are also many studies of other tropical countries in South East Asia region, such as Singapore and Malaysia, have recommended the basic concept for new design or discussed the real building as a case study. Joo Hwa Bay investigates the Bedok Court Condominium project which was an ideological re-

invention of traditional kampong living in Singapore [1]. Kamal compares the traditional Malay house with the modern housing-estate house, observes the differences of climatic design approaches, then recommended an adaptation design of traditional Malay house to meet requirements of comfort living in modern houses [8].

The traditional Vietnamese house is one of the richest components of Vietnam's cultural heritage. Designed and built by the villagers themselves, it manifests the creative and aesthetic skills of the Vietnamese. This is a near-perfect house form which is appropriate to local climatic conditions and expresses the way of life of its inhabitants. The folk houses in the North of Vietnam are considered as a typical style for Vietnamese traditional architecture having the ability to withstand severe weather conditions. The ecological architectural elements in this type of house have now become original cultural elements creating Vietnamese life style. The objective of this research is to investigate the application of eco-features in Vietnamese traditional folk housing to modern high-rise housing. At first, it introduces briefly about the climate and the environment in Northern Vietnam and their effects on traditional housing. Next, ecological elements are addressed by an architectural examination of the composition of the typical Northern Vietnamese folk housing in relation to the local climate conditions and Vietnamese life style. The result from actuality survey in Duong Lam, which is the oldest ancient village in Vietnam, are given. Finally, several models are proposed to apply the considered factors to urban high-rise housing design in urban Vietnam.

## **2. Climate and Environment in Northern Vietnam and Their Effect on Traditional Housing**

### **2.1 Hot-humid Tropical Climate and Environment in Northern Vietnam**

The climate of Northern Vietnam can be classified as warm-humid tropical climate, characterized by high temperatures and humidity [13]. Air temperature ranges from 5 to 6 degree Celsius in winter and up to 35 degree Celsius in summer and averages within 22 and 27 degree Celsius. Humidity is high through the year, averaging about 84% or more. In the summer, prevailing cool wind mainly comes from the south and east-south. The wind is generally of low-variable speed. Strong winds can occur with the rains. Rainfall is also high throughout the year averaging 150 to 200 cm annually (about 100 rainy days). Rains become more intense with the monsoons in the winter. The sunny hours are 1,500 to 2,000 and the average solar radiation is 100kcal/cm<sup>2</sup> in a year. Vegetation growth is sometimes difficult to control under the good conditions of air, moderate heat and high rainfall. Air flowing across any surface is subject to frictional effects. Wind speeds are higher with increasing heights and are lower near the ground where there are many obstructions. The relatively high percentages of reflected solar radiation from the sea, sky and beach make glare controls in houses necessary. Occasional strong winds which occur during monsoon seasons may pose serious hazards to houses and the settlers.

### **2.2 Effect of Local Climate and Environment on Vietnamese Traditional Housing**

The main causes of climatic stress in Northern Vietnam are “....high temperatures in summer, low temperatures in winter, solar radiation, humidity and glare” [13]. Therefore, to achieve climatic comfort in the houses, these factors must be controlled besides rain, floods and occasional strong winds. According to these demands, a general outline for Northern Vietnamese traditional folk housing is the consolidated plan form and the rectangular shape. Each building is organized for natural ventilation and illumination. The house faces south or south-east to maximize the wind in summer and to have shelter from the cold wind during winter. The east-west

orientation minimizes areas exposed to solar radiation. Open space is more popular than closed space. The front house is airy with terrace, main door, windows, and bamboo screen. However, the rear is a tight space with a few small windows to keep family privacy and to avoid cold in the winter. A semi-consolidated plan allows the air current to flow easily through the entire house and gets much benefit from the shadow cast by verandah, roof and green garden to reduce the surrounding high temperatures. For village planning in general and housing design in particular, green tree is always linked to water to improve the microclimate environment and establish a specific model of a garden, a pond and a cage [5].

### 3. An Examination of Architectural Composition of the Traditional Folk House Typical in Northern Vietnam

The architectural composition of traditional folk housing by conducting an analysis of typical housing in Northern Vietnam is presented in this paper. Vietnamese traditional folk houses have been designed in such a fashion as to take maximum advantage of the cool wind in the summer and minimize the influences of monsoon, to gather lots of sunlight in winter, to achieve better natural ventilation and provide good comfort.

#### 3.1 Configuration, Orientation and Spatial Composition

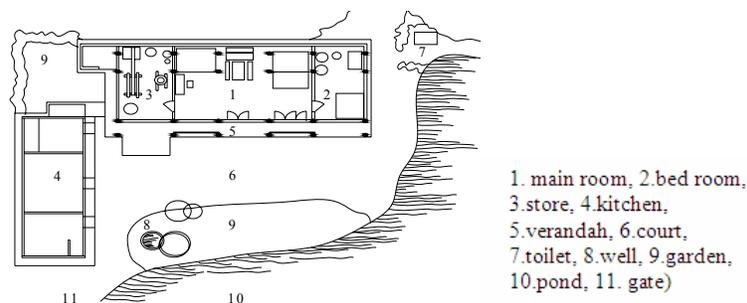


Figure. 1 Folk house typical in Northern

Basically, the house has two parts, i.e. main and secondary part. The main part is one-storey, long rectangular house, and orientated south or south-east. It has fundamentally five spans in width and three spans in depth. The depth of the eaves varies depending on the building. For houses with deep eaves, in some cases, the space under the eaves is transformed to interior space with placing partition, wall or fitting which made by laterite brick or wooden. Main part consists of main room at the center and outer rooms on both sides as shown in figure 1. The main room has four principal columns surrounded by side columns. In here, ancestor altar is placed at the center and both sides are living areas that is normally the bedroom of the head of the household. The outer rooms are mainly used as bedroom for children or young couples. Some cases, they are store or work place [3]. In keeping a smaller area, the secondary parts can be parallel or perpendicular and separated or connected with the main part to create in each a “well-aired” part individually. They include kitchen, toilet, breeding facilities and home craft space. The breeding facilities and toilet are laid out separately and usually at the end of winding pathway. The well is usually located near kitchen area. The well-water is used to wash, bath and cook.

#### 3.2 Natural Ventilation

The elongated open plans of the traditional house allow easy passage of air and good cross ventilation. There are minimal interior partitions in the Vietnamese house which restrict air movement in the house. Windows normally

covered by bamboo screens provide good ventilation and views for the house as shown in figure 3(c). Large doors and windows extend across almost the entire main façade and can be completely opened in the summer to take full advantage of the maximum prevailing cool wind as shown in figure 2(a). Conversely, only a few small windows are located in the rear to avoid the cold winter. Those windows, however, still allow penetrated ventilation when they are opened during the hot season. The eaves, which cover verandahs, are short to not block the southeastern cool wind from the exterior and to create wind slit to promote convection. In addition, natural ventilation is also encouraged by the gables that always contain air-holes as shown in figure 2(b).

### 3.3 Green Garden

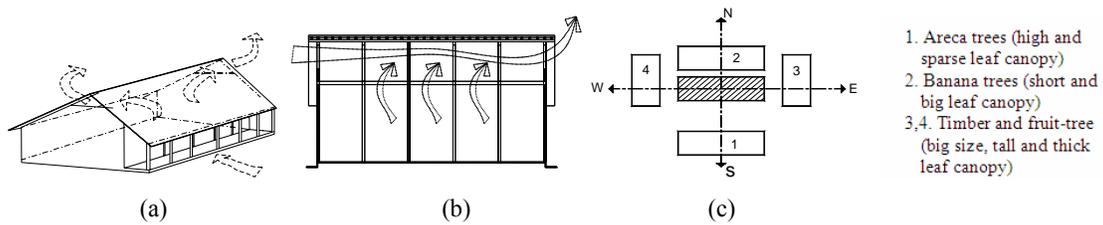


Figure. 2 (a) Ventilation in open façade; (b) Ventilation through two air-holes lengthwise section; (c) Planting green tree principle around house

Traditional folk dwelling-houses are cooled by suitable organization of ambient environment including verdure, water and yard. Along with providing vegetables, fruit, firewood and construction material, the garden is also a battery which keeps the whole house cool. Growing trees around the building follows fixed principles. In front of the house there is usually a bamboo lattice to shade the house from the sun and to adapt to the changing climate of Northern Vietnam. Most of the trees growing ahead of the rear (in the north) are short and have a big leafy canopy in order to reduce the direct effect of the monsoon. At the main facade of the house (in the south), on the contrary, the trees are high with small leaves and a sparse leaf canopy [6] as shown in figure 2(c).

### 3.4 Pond, Verandah and Court

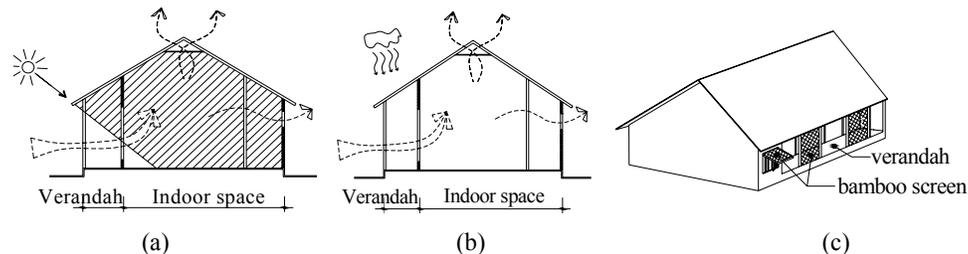


Figure. 3 (a) and (b) Verandah in cross section; (c) Bamboo screen in the facade

The linking between verdure and water has a significant role to improving the microclimate environment. In Vietnamese folk housing, a very special ecological element is the pond [7]. Besides providing material to build the foundation, digging the pond makes the site useful for collecting rainwater, breeding fish, growing water-ferns, taking a bath, soaking bamboo for construction, taking mud as manure, etc. The pond with many green trees around also has part to regulating the micro-climate. The steam emanating from this area contributes to natural ventilation. In the center of the master plan, all houses have yards serving as composed space for the building, a drying place in daytime and a place for relaxation at night. The combination of hot yard and verdure

creates thermal convection around the house. In order to prevent direct radiation and downpours, a verandah is constructed in every house. Being a transitional space from the court to the interior, the verandah plays a great role in adapting the severe climatic conditions in Vietnam. It prevents exposing the main space to the heat of the sun and reduces the wind-flow temperature throughout the home as shown in figure 3 (a) and (b).

### 3.5 Roof

Roofs, being the most important element in the control of solar radiation, are made from low-thermal-capacity materials. The roof has a high thermo-resistance and damp-proof capacity so it can protect the interior from the heat and the cold. Most of the roofs are covered with a lightweight and excellent thermal insulator made from thatch or straw (about 30-40cm), which hold little heat during the day and cools down at night. Otherwise, the roof can be covered by 2-3 layers of tiles [7]. Typical roof also has a high slope which helps the rain water to slip off easily and is a sustainable structure to withstand strong winds. Bamboo fabric is used on the roof-edge to avoid the damaging influence of storms. The extended roof piece can shelter the interior space from direct radiation and heavy rain.

### 3.6 Bamboo Screen

For adaptation to the changing climatic elements, the important element of the main facade are multi-functional bamboo screens which are used flexibly for shading, natural ventilation, preventing cold wind and creating individual or private spaces for occupants. This space is appropriate with the Vietnamese life-style because it is both open and secret, both hospitable and individual. These screens are usually in a square shape and can be in a fixed or controllable form. In comfortable weather, they are propped up to a suitable angle as shown in figure 4.

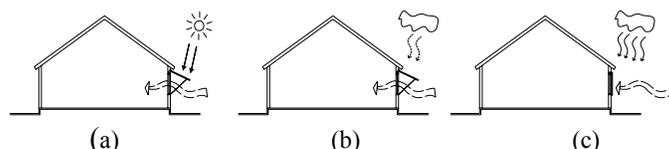


Figure. 4 Window with mobile bamboo screen in traditional house: (a) sunshine; (b) light rain; (c) heavy rain

### 3.7 Open Space

Open space includes some essential elements such as yard, courtyard, verandah, well, garden, pond, etc, thus outside spatial organization is also investigated. The yard and the verandah are organized to welcome visitors, to maximize the air flow, to enjoy the moonlight, to have dinner and to sleep at night. A well and a courtyard are often located next to the kitchen. During the hot season especially during muggy summer days, human activities occur mainly in the exterior space. In the rainy season, the verandah can be altered to a temporary storehouse.

### 3.8 Construction Material

Choosing construction materials contributes notably to maintaining the ecological features of Vietnamese traditional folk housing. The folk houses, made by local material, are called respiratory building. Made from soil, the foundation can regulate the humidity. Materials can self-breathe to their organic sources [5]. The building is to be shielded but not sealed up by its wall. The walls can be made of a mixture of soil and straw, air-dried earth or brick. It can also be made from clay mortar, a material that can absorb moisture and control humidity itself. The house was often made mainly of wood such as frame structure, roof, window, door, etc. Bamboo is usually used to make window, furniture and screen. The roof is covered by thatch, straw or tiles. The

yard is tiled by brick which can easily absorb water. These types of materials are organic and they can regulate humidity and self-disintegrate at the end of their lifecycle. Economical and reasonable choosing of vernacular material contributes to the architecture while adapting to the climate and harmony of nature.

#### 4. Result of actuality survey in Duong Lam village

Duong Lam Village, located 50km northwest of Hanoi City, has one of the largest aggregations of traditional folk houses in Vietnam. According to the actuality survey in Duong Lam village, it can be concluded that the spatial composition of traditional housing has particular characteristics as follows: The gate is always located perpendicularly but not faced directly to the main door of the living room. It makes the home at once delicate, private and hospitable which also created Vietnamese lifestyle characteristics; The green garden is laid out in three ways that are around the house, separate in front of the house and scattered between parts of the house as shown in figure 6(a). However, there is a common point of these ways, i.e. the green garden is always placed beside or inside the court; The depth of the verandah is depended on the building orientation and constantly next to the fore court; In general the verandah, forecourt and garden are always combined at the frontal-unit of a traditional folk house. The spatial composition models of traditional folk housing are summarized in figure 6(b).

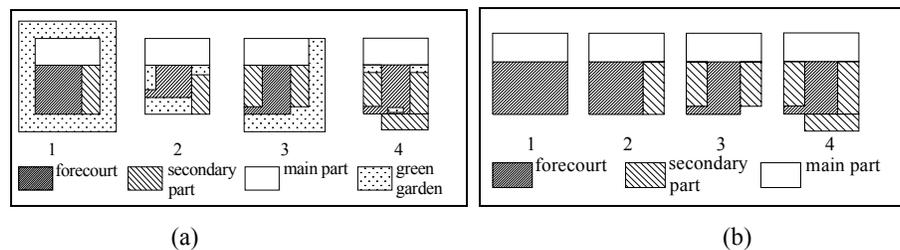


Figure. 6 (a) Green garden in traditional folk housing; (b) Spatial composition types of folk housing

The traditional folk house of the Northern delta's villages was extremely well designed to suit the hot-humid tropical climate, created with appropriately planned architectural measures which are linked with the natural environment and made a convenient microclimate for people. These are valuable properties that we need to inherit and develop in creating modern architecture as Vietnam as a country continues to grow and develop.

#### 5. Applying Ecological Elements of Traditional Folk Housing to Urban High-rise Housing of Vietnam

Using new theory and modern technology, the appearance of traditional building elements is a local identifier for the contemporary Vietnamese architecture. The ecological elements of folk housing applied to high-rise building must be considered in the correct perspective. Most of elements need a suitable change; some elements can be applied directly while others are inappropriate.

##### 5.1 Orientation and Natural Ventilation

In hot and humid regions, the natural ventilation should be the first design consideration. The south and south-east are the most fitting orientation of the native prevailing wind direction for Vietnamese dwellings as shown in figure 7(a). Then, in the long rectangle-shaped buildings, most apartments will be able to receive the prevailing cool wind and minimal spaces will be under the influence of direct sun from the west and also the east. Making

penetrated ventilation for every apartment is also necessary even though the building face a favorable orientation. The open plan is acceptable and suitable for high-rise housing.

## 5.2 Building Envelope

For climatic conditions in Vietnam, the housing façade should not be a “hermetically sealed skin” but “sieve-like”. These should have adjustable openings that operate as “filters having variable parts” to provide natural ventilation, to control cross-ventilation, to provide shade, to provide solar protection, to regulate wind-swept rain, to discharge heavy rain and to be insulated during the cold season [15]. In urban high-rise housing, the wall is the part absorbing the maximum heat radiation. For better living comfort, the proper insulation for the covered wall must be considered. However, to the top floor in the tropical skyscraper, the heat isolation is also absolutely needed. A ‘fly roof’ can be used to shade the entire most-top floors. It protects the core building from radiant heat and allows cooling breezes to flow beneath it. The vertical and cross ventilation model for façade skin and the roof are presented in figure 7(b). Making by new and modern materials, the conventional screen and window are able to support the strong wind pressure. This kind of net allows natural ventilation through horizontal opened plane while both shading sunshine and preventing light rain. It also prevents insulation, while permitting visual connection to the ground. The sloping window can be changed by vertical window or screen-shape shading structure with horizontal ventilation as shown in figure 7(c).

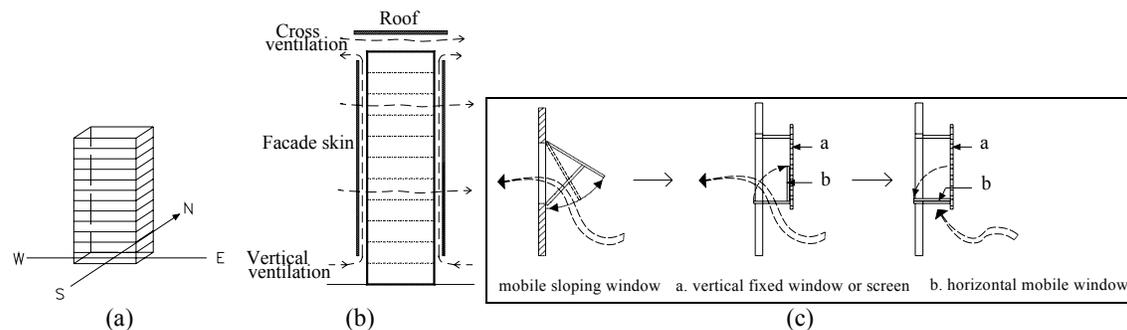


Figure. 7 (a) Fitting orientation of the urban high-rise housing; (b) Ventilation model for the façade and the roof; (c) Mobile window with horizontal ventilation

## 5.3 Greenery

Utilizing the concept of creating a green garden can improve indoor air quality, contribute significantly to a cooler building and preserve the ecosystem. As in traditional housing, greenery can be planted by many ways, for example a big gathered garden or many small dispersed gardens. However, creating physical continuity between planting is important for encouraging species diversity. To achieve physical continuity in “vertical landscaping” in high-rise housing, the system should be linked [14]. Tropical verdure closes with Vietnamese living from the past to the present so it must be considered in design. In high-rise building, green space can be used not only a private space for one family but also a common place for relaxation and communication. In addition, the water element should also be studied in modern design to improve cooling and landscaping effects.

## 5.4 Open Space

The open or semi-open spaces for outdoor activities are friendly with lifestyle of Vietnamese people and are usually existed in Vietnamese housing. Hence the designers must comprehend and incorporate this feature into

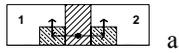
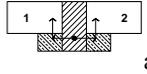
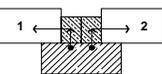
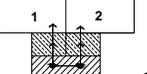
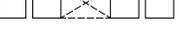
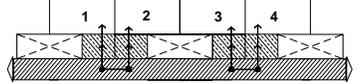
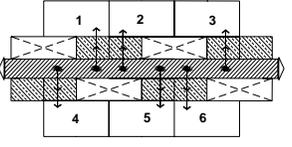
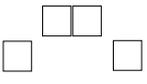
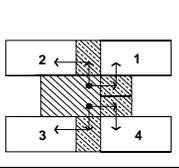
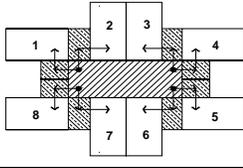
the high-rise housing structure. In traditional house, the open-air behaviors are mostly happened at the verandah and the court which are located in the center of the house and extended from indoor to outdoor area. For high-rise house, such spaces should be a sky-verandah, for instance a forecourt, where the extended living room and relaxation space are. Every forecourt must contain at least one side being in contact with the nature to get daylight and ventilation. As a result, four cases of the combined solutions between forecourt and living space in high-rise apartment unit are proposed in Table 1.

Table 1. Combined solutions between forecourt and living space

Traditional folk housing	 a	 b	 c	 d
High-rise apartment	 a1	 b1	 c2	

Notation:  forecourt  space apartment unit / living space

Table 2. Combined solutions of the forecourt in urban high-rise apartment of urban Vietnam

C	Combined cases of forecourt	Proposed designs	
a		 a <sub>1</sub>	 a <sub>2</sub>
b	 b	 b <sub>1</sub>	 b <sub>2</sub>
c	 (with patio)	 c <sub>1</sub>	 c <sub>2</sub>
d		 e <sub>1</sub>	 e <sub>2</sub>
Notation		 forecourt	 traffic space  apartment unit

In an apartment unit, serving as an access and threshold space, the forecourt or the sky-verandah can allow penetrated ventilation and also support or create an environment which is conducive to various forms of human activities both during daytime and at night. This space gives the opportunity for social communication in family life and community as well as being eco-friendly. In the access side of every dwelling unit, it can be positioned centrally or peripherally of the unit. It can also be located to protect the hot sides of the building or to frame an

important view. The combination of communicate spaces on the plan is showed as figure 8. Each two forecourts can be combined and then two forecourts are shared one courtyard.

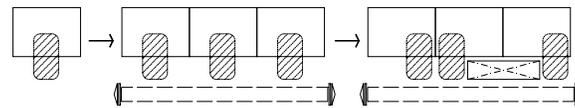


Figure. 8 Combination of communicate spaces on the plan

The forecourt unit in the residential high-rise can be stacked modularly in a variety of ways. This facilitates growth and contraction further enhancing the concept of lifetime communities. As a above discussion, the forecourt provide as neighbor communicate place, thus their combination needs to be considered. Apart from being linked with the common lobby and the living room, the forecourt must be directly linked with nature. In each closed group, it should be from 1 to 4 units to keep private life and to reduce the influence of the neighbors. A number of designs of the forecourt group in Vietnamese urban high-rise housing are given in Table 2.

### 5.5 Others

For creating a 'sieve-like' skin façade style which is suitable with the tropical climate, the eave can be altered into the porch roof as shown in figure 9(a); traditional verandah can be changed into balcony, loggia, sky-terrace or forecourt as shown in figure 9(b); etc. Other great lesson need to be learned from the past that is choosing the suitable vernacular and the modern material which is light weight, green, non-toxic, durable and recycled. The recycled processes such as water and waste renewing should be considered. The rain water collecting system should be planned in the high-rise because of its large surface received rainwater, especially in the high-rate rainfall country as Vietnam. When planting up to the sky, it is crucial for the designer to ensure that the shading effect and the preventing cold wind in winter are improved and the cool wind penetrated through the building in summer are encouraged. Avoid excessive thermal gains and excessive brightness resulting from direct sunlight, which can impair vision and cause discomfort. Use indirect lighting through reflecting ceiling and equip with traditional elements such as shades, screens or light shelves.

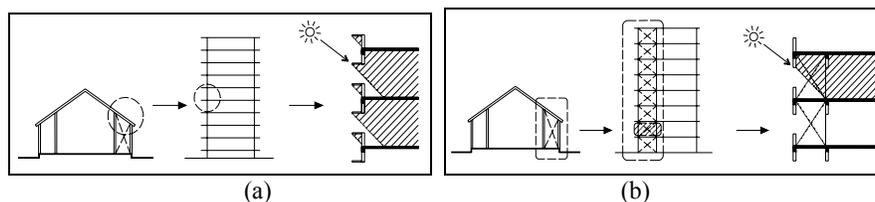


Figure. 9 (a) Shading by eaves; (b) Shading by transitional space

### 6. Conclusion

A Vietnamese vernacular version of architecture in hot and humid tropical climate is a representation of logical architecture for providing all living comforts in similar environments. The use of the semi-consolidated plan, the link between the green garden and the water reduce considerably the surrounding heat. The natural ventilation is designed suitably to remove the humidity and provide a cool wind in the interior. Semi-open spaces such as the verandah, the bamboo screen, the wide door and the air-hole in the roof increase passing ventilation. The organic sources and locally-made material is used mainly. All above observations indicate how people who planned such buildings understood the environmental conditions well. The great lesson is that humans must have the right attitude and harmony in dealing with the natural environment while not damaging nature. Passive design method

used in the past can be applied basically to contemporary housing. However, each architectural element must incorporate suitable changes according to the environment in urban high-rise apartment. This approach brings about not only a positive effect on the living environment through passive design solutions but also great significance for culture and society.

## 7. References

- [1] Bay Joo-Hwa (2004). Sustainable Community and Environment in Tropical Singapore High-rise Housing: the Case of Bedok Court Condominium. *Environmental Design/Arq.* Vol. 8, Nos. 3-4, pp. 333-343, Singapore.
- [2] Brian Edwards (2001). Green Architecture. *Architectural Design*, Vol. 71, No. 4.
- [3] Charles J. Kibert (2005). *Sustainable Construction - Green Building Design and Delivery*. John Wiley&Sons Inc.
- [4] Ho, D.C and Tran, V.K (2006). The Eco-housing in Ho Chi Minh City. In *Proceeding Conference of Architects Association of Ho Chi Minh City, Vietnam* (in Vietnamese).
- [5] Hoang, D.K (2004). The Natural and Hot-humid Tropical Elements in Composition of Architectural Character. *Vietnamese Architecture Journal*, Vol. 12 (116), pp. 24-29 (in Vietnamese).
- [6] Hoang, H.T (2006a). Vietnamese Ecological Architecture. *Vietnamese Architecture Journal*, Vol. 3 (126), pp. 48-52 (in Vietnamese).
- [7] Hoang, H.T (2006b). Tropical Climate and Architecture of the Traditional Villages in the North Vietnam. *Vietnamese Architecture Journal*, Vol. 11 (126), pp. 42-45 (in Vietnamese).
- [8] Kamal, K.S., Wahab, L.A. and Ahmad A.C. (2006). Adaptation Design of Traditional Malay House to Meet the Requirements of Comfort Living in Modern Houses. *Journal: The Malaysian Surveyor*, Vol. 40.1, pp. 43-48.
- [9] Ngo, H.Q (2000). A study on Vietnamese Architectural History. *Construction Publishing House*, Vietnam (in Vietnamese).
- [10] Nguyen, M.S (2006). Architectural Ecologicalization – the Self-regulated Tropical Architecture Pattern. *Vietnamese Architecture Journal*, Vol. 8 (126), pp. 44-47 (in Vietnamese).
- [11] Nguyen Viet Ninh (2006). The eco High-rise Housing in Vietnam. *Vietnamese Architecture Journal*, Vol. 8 (136), pp. 55-59 (in Vietnamese).
- [12] Shohouhian, M. and Soflaee, F. (2005). Environmental Sustainable Iranian Traditional Architecture in Hot-humid Regions. *International Conference “Passive and Low Energy Cooling for the Built Environment”*, pp. 173-178, Santorin, Greece.
- [13] Vietnamese Architecture Research Institute (1997). *The Architecture and Tropical Climate in Vietnam*. Construction Publishing House, Vietnam (in Vietnamese).
- [14] Yeang Kenneth (1998). Research Information: Designing the Green Skyscraper. *Building Research & Information*, Vol. 26-2, pp.122-141.
- [15] Yeang Kenneth (2006). *Ecodesign – a Manual for Ecological Design*. Wiley-Academic.