

A Study on Living Environment in Flood-Prone Village, the Traditional Urban Area of Hue, Vietnam

A Case of Kim-Long Ward, Periphery of the Hue-Citadel

Takahiro Izumi*, Naoaki Furukawa**and Shigeru Satoh***

Abstract:

Many villages being located along the Huong River flowing through the center of the Hue city have been developed and maintained over centuries, despite repeated floodwater damages caused by the South-eastern Asian monsoon climate. Among those villages, Kim Long Ward as the study area had existed even before the Nguyễn Dynasty, the last imperial dynasty of Vietnam (from 1802 to 1945), despite a location damaged seriously by annual flood (especially in 1999) in the midstream of the Huong River.

There are concerns that the flood damages will become more and more serious because recent urbanization might cause a loss of the traditional culture of life including the land use and lifestyles which have been adapted to natural environment over many generations. Thus, we conducted analysis of various maps, interview to local inhabitants and drawing the site plans of dwellings to research sustainable development of flood-prone villages.

In this study, it was defined that most of villages along the Huong River have been located while considering the flood damage mitigation and the geological feature in each region. However, the flood damage in Kim Long has been getting more and more serious by the changes of the forms of rivers at the construction of the Hue-Citadel and the changes of land use contributing to flood mitigation after Vietnam War until the present time. In addition, in process of subdivision of the housing lots in each dwelling associated with the changes of land use density growth of the dwellings was caused remarkably in the case of sale or transfer of a part of a housing lot to unrelated persons. Owing to that, bad ventilation condition and loss of the garden for rainwater infiltration were caused. Meanwhile, local inhabitants have the measures to take a precaution against floods. However, that might be limited as long as there are changes as mentioned above.

Keywords:

Vietnam, Hue, Flood Damages, Garden House, Living Environment

* Master Course, Graduated School of Science and Engineering, Waseda University

** Project Assistant Prof., Faculty of Urban Environmental Sciences, Tokyo Metropolitan University

*** Prof., Faculty of Science and Engineering, Waseda University

E-Mail: it.91515@gmail.com

1. A PREFACE

1-1. Background

Hue in the geographical center of Vietnam prospered as the capital of Nguyễn Dynasty. Besides, the complex of historical monuments in Hue was designated as UNESCO World Heritage sites in 1993.

Many villages being located along the Huong River flowing through the center of the Hue city have been developed and maintained over centuries, despite repeated floodwater damages caused by the South-eastern Asian monsoon climate. However, there are concerns that recent urbanization in Hue might cause a loss of the traditional culture of life including the land

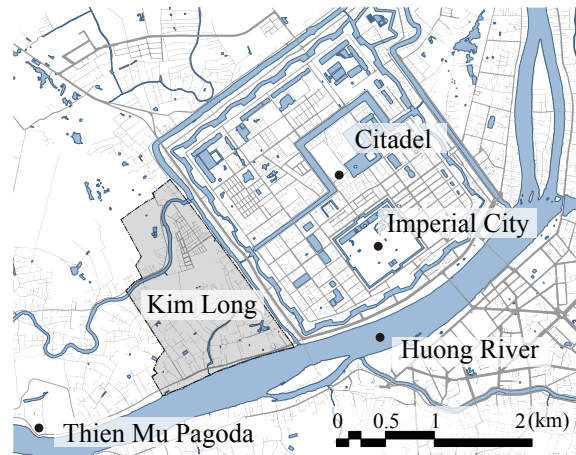


Figure 1-1: Studied Area

use and lifestyles which have been adapted to natural environment over many generations. Thus, it is quite important for moderns to research sustainable development of such villages by defining the characteristics of the village location and the traditional lifestyle of local inhabitants.

1-2. Current States of the Studied Area

The subject of this research is the Kim Long Ward (hereinafter referred to as Kim-Long) where had existed even before the Nguyễn Dynasty despite a location damaged seriously by annual flood (especially, flood in 1999⁽¹⁾) in the midstream of the Huong River (Figure 1-1). This area has a lot of ‘Garden Houses (Nhà Lương)’⁽²⁾ where government officials who served the dynasty lived in the Nguyễn Era. It’s contemplated that the Garden Houses are harmonized with the surrounding natural environment (incl. sunlight, ventilation and rain infiltration) because the Feng-Shui⁽³⁾ concept has been applied to design of the Garden Houses.

Meanwhile, Kim Long is susceptible to tourism urbanization due to being located between the Citadel (the Walled Town of Hue) and Thiên Mụ Pagoda which are both registered in the UNESCO World Heritage. In addition, there are concerns that the damages by storm of rainfall might become more serious because of density growth of dwellings being accompanied with the subdivision of each housing lot⁽⁴⁾.

1-3. Purpose

The goals of this research are 3 points as follows: (1) to define features of the village location of the Kim-Long and main factors of serious damages by repeated floods, (2) to clarify the current state and factors of subdivision of the housing lots that causes density growth of the dwellings, (3) to describe lifestyle of local inhabitants living together with harsh water environment.

1-4. Research Methodology

Figure 1-2 shows the research flow of this paper. This paper, first, tries to define the transformation of the village from the Nguyễn Era to the present by reviewing historical documents and interviewing to the manager of Đình⁽⁵⁾ (Community House of Village) and interviewing inhabitants who live in the Garden Houses,

then clarifies the current situation and factors of flood damages in Kim-Long by comparing the land use in both the post Nguyễn Era and the present through the analysis of the geological map (Y. Hirai 2008¹⁾) and flood inundation map⁽⁶⁾ in 1999 (Pham Hong Nga 2007²⁾) (Ch.2).

Second, defining the mechanism and features of subdivision of the housing lots of the Garden Houses which is the one of the main factors of flood by breaking factors of subdivision of the housing lots down into patterns (Ch.3).

Futhermore, grasping the actual condition of the living environment and to the way of taking a precaution against floods in daily life through the interview to Garden House dwellers and the measuring survey of the Garden Houses, in order to define how the local inhabitants live together with harsh water environment (Ch.4).

Finally, concluding the sustainable way of living together with harsh water environment in Kim-Long by taking the current issues and living conditions into consideration (Ch.5).

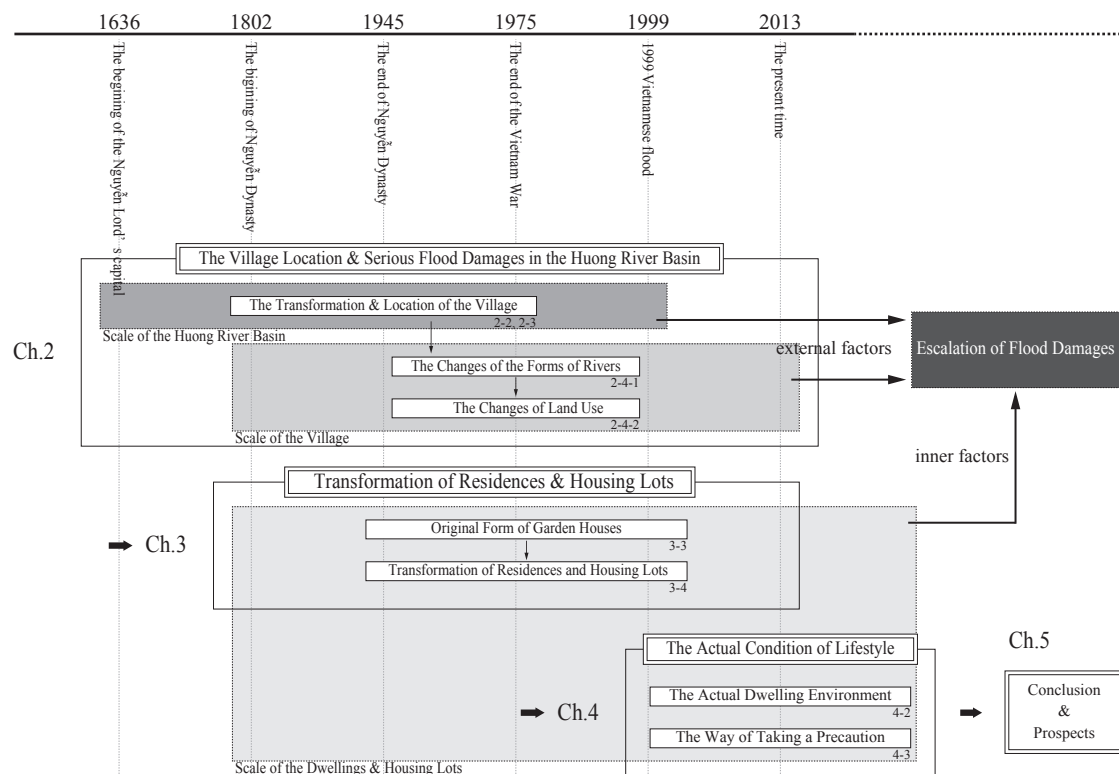


Figure 1-2: Research Flow

1-5. General Contents and Methods of the Investigation

In this study, we implemented three steps below, dating from 16th August to 12th September 2013.

1) Making base maps for the analysis of the studied area

Old map in a historical document, Topographical map including altitude data, Land use map based on old maps and investigation of interview

2) Interview through an English-Vietnamese interpreter

Interviewees are inhabitants who live in the Garden Houses, local inhabitants who live along the ex-Kim-Long River, the manager of Đình, an officer of Kim-Long People's Committee, and vendors in Kim-Long Market. The way of interview is using interview sheets and writing down

in English.

3) Drawing the site plans of the Garden Houses under the cooperation with a graduate student of Hue University of Science to describe the actual condition of dwellings.

Why this paper focuses on the Garden House is that it is essential to describe the village transformation. Furthermore, it can be thought that moderns can learn the wisdom for the traditional environmental control from the designs (incl. location and plan) of Garden Houses the Feng-Shui Methodology is applied to the symbiotic design of Garden Houses to harmonize with surrounding natural environment.

2. ANALYSIS OF THE FEATURES OF THE VILLAGE LOCATION OF KIM-LONG AND THE FACTORS OF FLOOD DAMAGES

This chapter focuss on the features of the village location in Huong River Basin and the factors of flood damages in Kim-Long which have been aggravated in recent years..

2-1. Method of Investigation

1) Investigation of documents in which city planning under the construction of the Hue-Citadel is described,

2) Analysis on a map made in 1968 ³⁾, a geological map, a flood inundation map (1999), a topographical map, an existing land use map collected from the Kim-Long Ward People's Committee

3) Interview to the local inhabitants about the land use change till now

4) Plotting the existing land use through the field investigation

Period: from 16th August to 12th September 2013

2-2. History and Transformation of Kim-Long

Firstly, the history of the Kim-Long in and before Nguyễn Era is summarized below based on historical document survey. Then the village transformation influenced by the Vietnam War is defined through the interview to local inhabitants.

• The era of the Nguyễn Lord's capital:

The capital of the Central Vietnam was relocated to the Kim-Long at the east of the Thiên Mụ Pagoda by Nguyễn Lord in 1636. This land, which was made from soil deposited by Huong River and Kim Long River, was appropriate for not only Feng-Shui concepts but also expansion of the city or economic development ⁴⁾.

• During the era of Nguyễn Dynasty:

Kim-Long has turned to the residential area of the governmental officials of the dynasty since sceptor Gia-Long (First Emperor) established Nguyễn Dynasty in 1802. Besides, the forms of two rivers (Kim Long River and Bạch Yến River) flowing through Kim Long were transformed at the construction of the Hue-Citadel ⁵⁾.

• Drastic turn during the Vietnam War and postwar era:

The Vietnam War resulted in significant change on Kim-Long in terms of increase in the ruined houses. Furthermore, the subdivision of housing lots caused by population inflow, and return of the land restitution to the government in the postwar era.

2-3. The Features of the Location in Huong River Basin and Exceptional Flood Damages

As the result of superimposing the locations of settlements (GIS data 2000) in Huong River Basin upon the geological map from the research achievement by Hirai and a flood inundation map (1999) by Pham, most of settlements have been established on the natural levees⁽⁷⁾ (Figure 2-1). In addition, it was shown that the settlements have not been basically established in the areas suffered from flood damage in the midstream and upstream of the Huong River (Figure 2-2).

However, Kim-Long has different characteristics from the other villages in terms of having been seriously damaged by flood in spite of being located on the natural levee.

2-4. The Factors of Exceptional Flood Damages in Kim-Long

2-4-1. The Changes of the Forms of Rivers at the Construction of the Hue-Citadel

The details of the changes of the forms of two rivers, as mentioned in 2-2, are as follows (Figure 2-3).

▪ ex-Kim-Long River:

This river doesn't flow at the present because it was dammed up when Citadel was constructed. However, inhabitants who live along ex-Kim Long River answered that water comes from Huong River into ex- Kim Long River during floods; therefore it was evident that the previous form of the river affects present flow of water.

▪ Bạch Yến River:

This river was not dammed up completely like ex-Kim-Long River and connected with Defensive River of the Hue-Citadel.

The outstanding flood damage in 1999 in the basins of these two streams is likely to be caused by the changes of the forms of rivers at the construction of the Hue-Citadel.

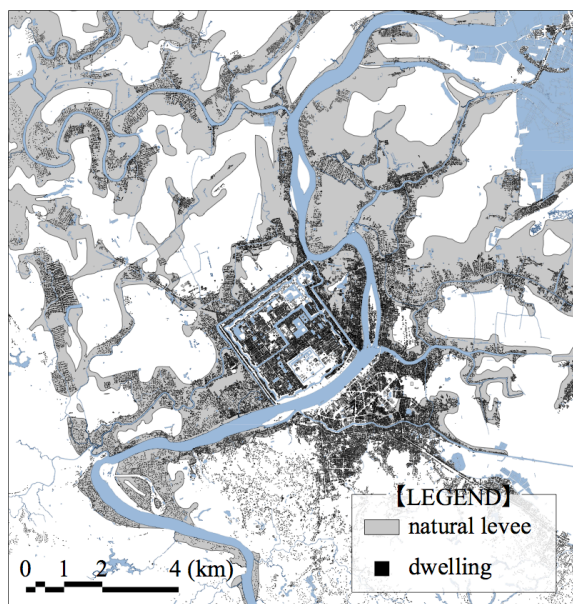


Figure 2-1: Relationship between Natural Levee & Village Location

Source: Reference 1)

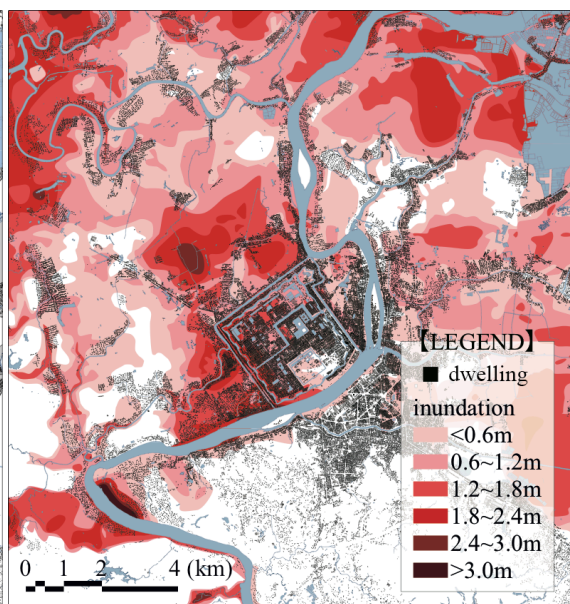


Figure 2-2: Relationship between Flood Damage in 1999 & Village Location

Source: Reference 2)

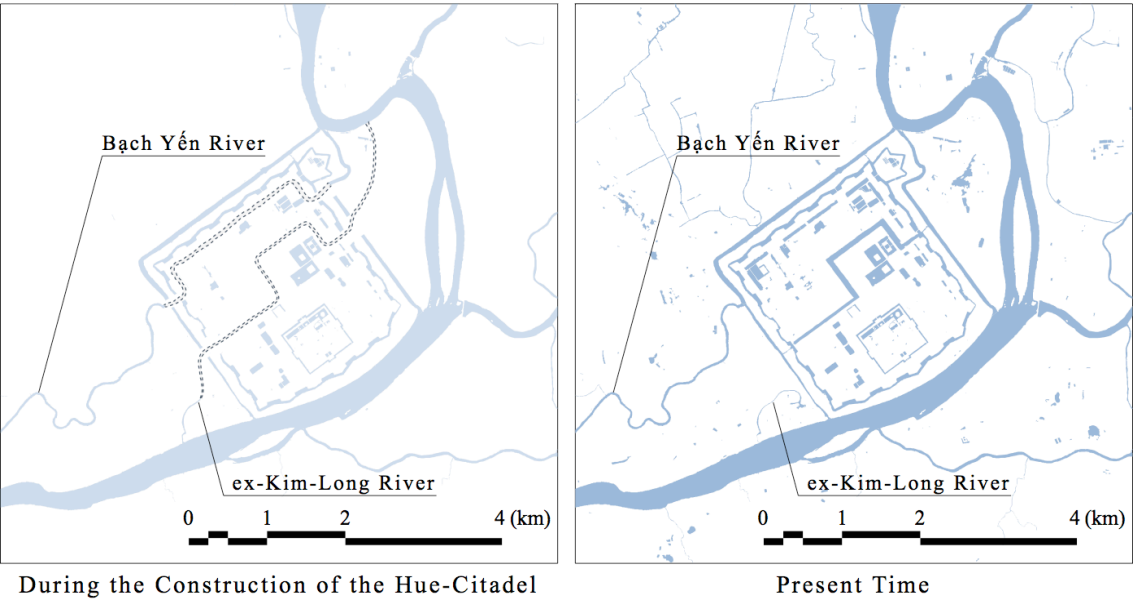


Figure 2-3: The Changes of the Forms of Two Rivers
Source: Reference 5)

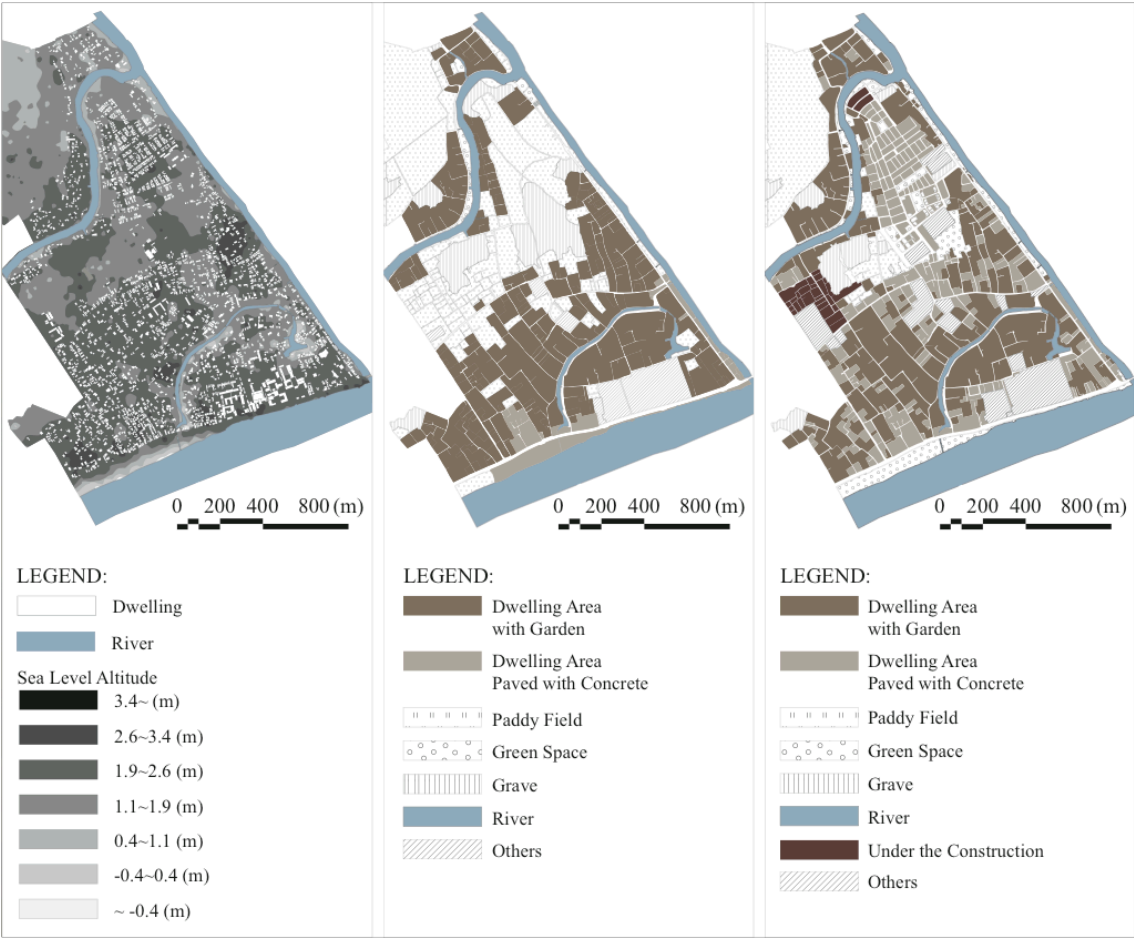


Figure 2-4: Topography Map

**Figure 2-5: Land Use Map
in 1968**

Source: Reference 3)

**Figure 2-6: Land Use Map
at the Present**

2-4-2. The Changes of Land Use contributing to Flood Mitigation in Kim-Long

- Decrease in the paddy field:

As is evident from Figure 2-4, 2-5, and 2-6, the paddy field has been arranged in a low-lying land, and the residential area has been established on a slightly elevated land.

Bách Yến River was a land for grave and paddy field that was seen as flood plain in 1999, however, resettlement area for houseboat dwellers was constructed there in 2002. Owing to this, there are concerns that flood damages will become more serious from now on by changing conventional land use which has been taken flood into account as mentioned above.

- Decrease in the green space: In addition to above, it is remarkable to decrease in the green space in residential area by subdivision of housing lots in each house after Vietnam War or in recent years. It is assumed that previous green space was taking on a role against flood because inhabitants mentioned that unpaved ground with concrete is well drained.

As the result of the analysis of comparison between land use map and topography map, it was clarified that the previous land use could contribute to mitigating flood damages. However the land use is changing with accompanying urbanization at the present.

2.5 Summary

In this chapter, the factors that have occurred the current harsh water environment in Kim-Long on the scale of the village are defined below:

- Most of villages along the Huong River have been located while considering the flood damage mitigation and the geological feature in each region.
- The flood damage in Kim Long has been getting more and more serious in spite of being located on the natural levee for the following 3 reasons; 1) the changes of the formations of two rivers at the construction of the Hue-Citadel and 2) subdivision of the housing lots due to population growth in this village and 3) decrease of paddy fields and green areas after Vietnam War until the present time.

3. TRANSFORMATION OF DWELLING AND HOUSING LOTS OF GARDEN HOUSES IN KIM-LONG

This chapter focuss on the one of the main factors of harsh water environment in Kim-Long on the scale of residences and housing lots through defining the mechanism and features of subdivision of the housing lots of the Garden Houses

3-1. Method of Investigation

Review of previous researches on Garden Houses, Measuring Garden Houses and the housing lots, Interview to the local inhabitants on the living environment and family structure, How and Why of renovation/rebuilding of each Garden House, Taking photographic intelligence in Garden

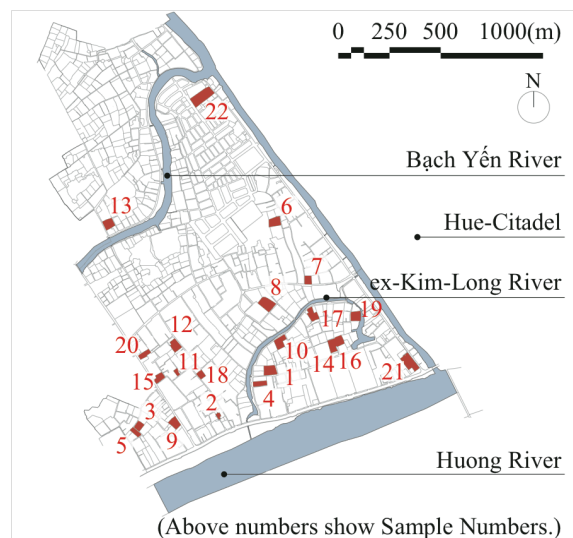


Figure 3-1: The Target Garden Houses

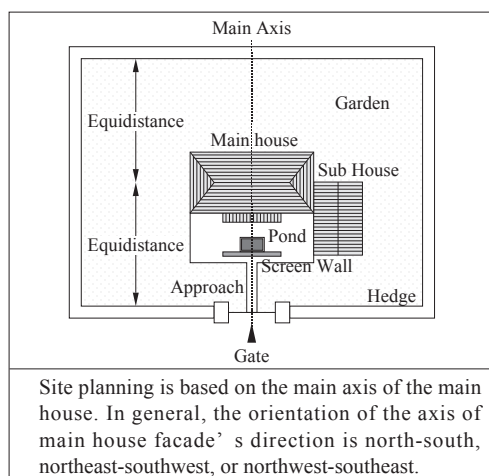


Figure 3-2: Space Composition of the Garden Houses

Houses and the housing lots in Kim-Long

Period: from 16th August to 12th September 2013

3-2. The Target Houses

Figure 3-1 shows the Garden Houses that were subject to the investigation. The number of samples for the investigation is 22 Garden Houses that were permitted for us to conduct survey among 28 in total in the Kim-Long.

3-3. Precondition to Study the Transformation of Dwellings and Housing Lots of Garden Houses in Kim-Long

Figure 3-2 shows typical space composition of the garden house to indicate tendency of main house's ⁽⁸⁾ location in the housing lot.

According to the previous study ⁶⁾ by Le Ngoc Van Anh and Fausto Pugnali, each Garden House gets a good ventilation condition if the orientation of the axis of its facade's direction is north-south,

Table 3-1: Orientation of the Main Axis

Orientation of the Main Axis	Corresponding Number of Households
North-South	3
East-West	1
Northeast-Southwest	10
Northwest-Southeast	8

Table 3-2: Orientation of the Main Facade

Orientation of the Facade	Corresponding Number of Households
South	3
Southeast	8
Southwest	5
Northeast	3
Northwest	2
East	1

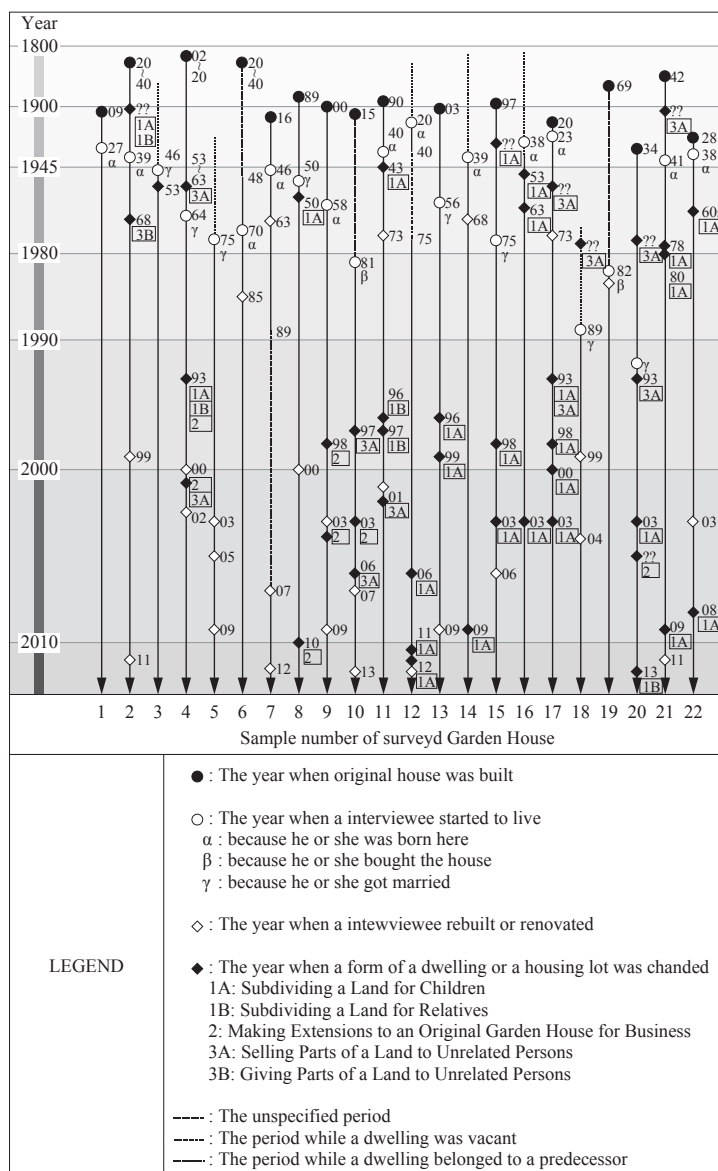


Figure 3-3: Sorting Out the Transformation of Dwellings & Housing Lots

northeast-southwest, or northwest-southeast. Especially, the facade facing south, southeast, or southwest offers the advantage of letting in sunlight. Thus, most of the surveyed Garden Houses in Kim-Long also had the orientation that takes ventilation and sunlight condition into consideration (Table 3-1, 3-2).

3-4. Sorting Out the Transformation of Dwellings and Housing Lots

Transformation of dwellings and housing lots was sorted out (Figure 3-3) and defined in stage (Figure 3-4) from the interview to those who live in garden house about the year and the factor

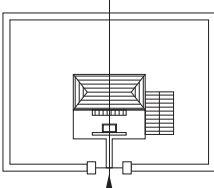
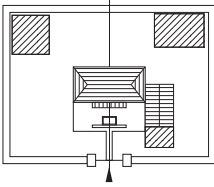
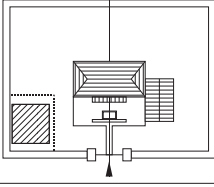
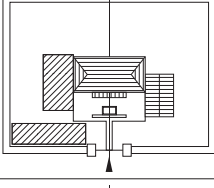
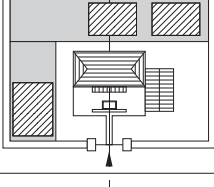
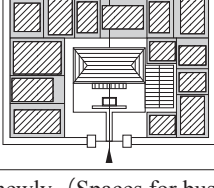


TYPE	Name of TYPE	Model	Definition / Tendency	Corresponding Number
0	Prototype		Definition: A land has not been subdivided. The composition of a housing lot and a dwelling has not changed. Tendency: Dwelling environment that founder intended still exists.	6
1	1A Subdividing a Land for Children		Definition: A land was subdivided for children because children begin to keep house. Tendency: New house was built beside the main house or on one of for corners of a housing lot. (27/28 Cases)	28
	1B Subdividing a Land for Relatives		Definition: A land was subdivided for relatives to provide a living space for them. Tendency: New house was built on one of for corners. Then, a concrete masonry wall was built on the boundary. (3/5 Cases)	5
2	Making Extensions to an Original Garden House for Business		Definition: A space for business was made in a housing lot. Tendency: Cafe, lumbermill, and so on was made besides a main house, sub house or along a road. They are semi-outdoor space. (6/7 Cases)	7
3	3A Selling Parts of a Land to Unrelated Persons		Definition: Parts of a land were sold to unrelated persons to raise money. Tendency: Parts of a land behind or beside the main house were sold. Then, concrete masonry wall was built on the boundary. (10/10 Cases)	10
	3B Giving Parts of a Land to Unrelated Persons		Definition: Parts of a land are given to unrelated persons to provide a living space for them. Tendency: Parts of a land were given during the Vietnam War. The housing density was increased. (1/1 Cases)	1
<p>LEGEND:  Houses built newly (Spaces for business in TYPE 2)</p> <p> Parts of a land passed into unrelated persons</p>				

Figure 3-4: Definition & Tendency of Transformation of Dwellings & Housing Lots

that they changed the form of dwellings and housing lots since they started to live there. Regarding to clarification and definition as above, Figure 3-5 shows model of transformation of Dwellings and housing lots in sample number 4 that included all types of transformation except Type-3B. The features of each type as follows.

TYPE 0: Prototype

Dwelling environment that founder intended for adaptation to surrounding nature still exists in spite of the changes of design by restoration.

TYPE 1: Subdividing a Land to Children or Relatives

Following two types (1A and 1B) showed that the new house was not built on the axial direction of main house facade in all cases; therefore, it is evident that conventional features of the garden house was taken into consideration when the new house of children or relatives was built. The features of each type are mentioned below.

TYPE 1B: Subdividing a Land for Relatives

All households that applied to this type also applied to TYPE 3 as follows. Therefore, it was revealed that they didn't have a resistance to subdivide their lands.

TYPE 2: Making Extensions to an Original Garden House for Business

The enlargement of the space for business did not obstruct conventional ventilation because all surveyed spaces for business was semi-outdoor space. It was assumed that this space was made depending on the situation of each household although all cases are identified as occurred in the 1990s.

TYPE 3: Selling or Giving Parts of a Land to Unrelated Persons

It confirmed that a part of the housing lot behind the main house was passed into unrelated persons in 6 cases, and beside the main house in 4 cases. As for the households that sold housing lots behind the main houses, ventilation condition became uncomfortable because another person's house or concrete masonry wall was built close behind the main house. Moreover, lost of a large part of garden was caused by selling or giving a part of each housing lot. Following two types (3A and 3B) showed that the features of the main house as mentioned in 3-2 were not taken into account and the form of the housing lot was out of control of original landowners.

TYPE 3A: Selling Parts of a Land to Unrelated Person

The reasons why a part of housing lot was sold were

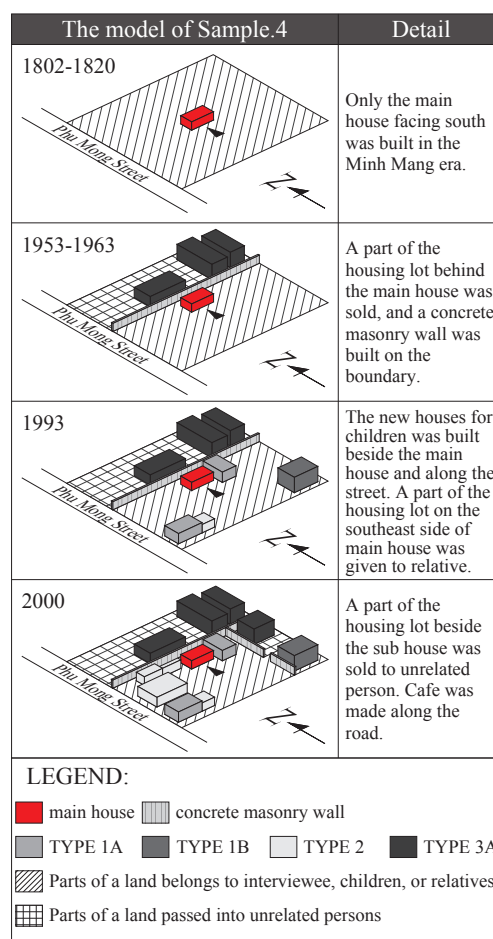


Figure 3-5: Example of Transformation of Dwellings & Housing Lots (Sample 4)

to raise living expenses in 1 case, and to raise repair costs in 3 cases among the 4 valid respondents. All cases of this type were seen before 2005 when regulation on the garden house was shown by people's committee⁽⁹⁾; therefore, it seems that inhabitants have been forced to have a hard life because they can't sell the housing lot to raise living expenses or repair cost, while the formation of the housing lot is conserved to a certain extent after 2005.

TYPE 3B: Giving Parts of Land to Unrelated Person

The housing density was increased by in-migration after the Vietnam War and inhabitants answered that ventilation condition was not good in only 1 case corresponding to this type.

3-5. Summary

In this chapter, the features of the transformation of housing lots of the Garden Houses that had covered most area in Kim Long originally was defined as below:

- Transformation of dwellings and housing lots includes 3 types: 1) Subdividing a Land to Children or Relatives, 2) Making Extensions to an Original Garden House for Business, 3) Selling or Giving Parts of a Land to Unrelated Persons. Each type has the feature about the location of divided housing lot.
- The location of the main house is taken into account in all samples except for TYPE 3) ; therefore, increase in density of dwellings in Kim-Long causes bad ventilation condition and loss of the garden for rainwater infiltration.

4. THE ACTUAL CONDITION OF LIVING ENVIRONMENT AND CURRENT LIFESTYLES WITH ADAPTATION TO NATURAL ENVIRONMENT

This chapter focuss on the current condition of lifestyle with adaptation to natural environment, especially in the harsh water environment, by understanding the way to manage the living environment in daily life and to take precautions against repeated floods.

4-1. Method of Investigation

- 1) Drawing site plans of the Garden Houses
- 2) Drawing plan and furniture arrangement in the Garden Houses
- 3) Interview to the local inhabitants living in the Garden Houses about the living spaces, measures to take a precaution against floods, and intention
- 4) Taking pictures in the housing lots of the Garden Houses

Period: from 16th August to 12th September 2013

4-2. Daily Management of the Living Environment in the Garden Houses

4-2-1. Indoor Living Environment

The current lifestyles were clarified through drawing the plan and furniture arrangement in the main house that was built in the housing lot in the earliest period (Figure 4-1). According to investigation using interview to inhabitants who live in the garden house, all of them answered that cool breeze came from windows and doors and that it was cooler in the morning than afternoon. Moreover, over 70 % interviewees of samples answered that it was cooler in the traditional house than the contemporary house.

- **The way to use the main house:**

As the result of description of furniture arrangement in the main house, there were 5 types of usage of space: for worshipping, sleeping, relaxing, serving, and storage; inhabitants stayed in each living space for a while.

- **The relationship between ventilation condition and life:**

As shown in Figure 4-1, a certain tendency to put spaces for sleeping, resting, and serving near openings was identified through this study.

4-2-2. Outdoor Living Environment Related to Water

- **Water use in the housing lot:**

Wells and rainwater tanks are used in 12 households among surveyed 22 samples in total. These are now used for gardening mainly.

- **Water use in the river:**

16 households answered that they have used river water for bathing, washing, or even swimming. However, currently only 2 households among the 16 samples as above are using river water. They quitted using river water principally because they didn't have to use river water thanks to the construction of the water-supply system, and partly because river water became contaminated owing to bad water circulation caused by sand deposition associated with repeated flood and throwing garbage into the rivers.

4-3. Gradual Countermeasures for Taking Precautions against Repeated Floods

It was clarified that there were 3 measures for Taking Precautions against Repeated Floods: (1)

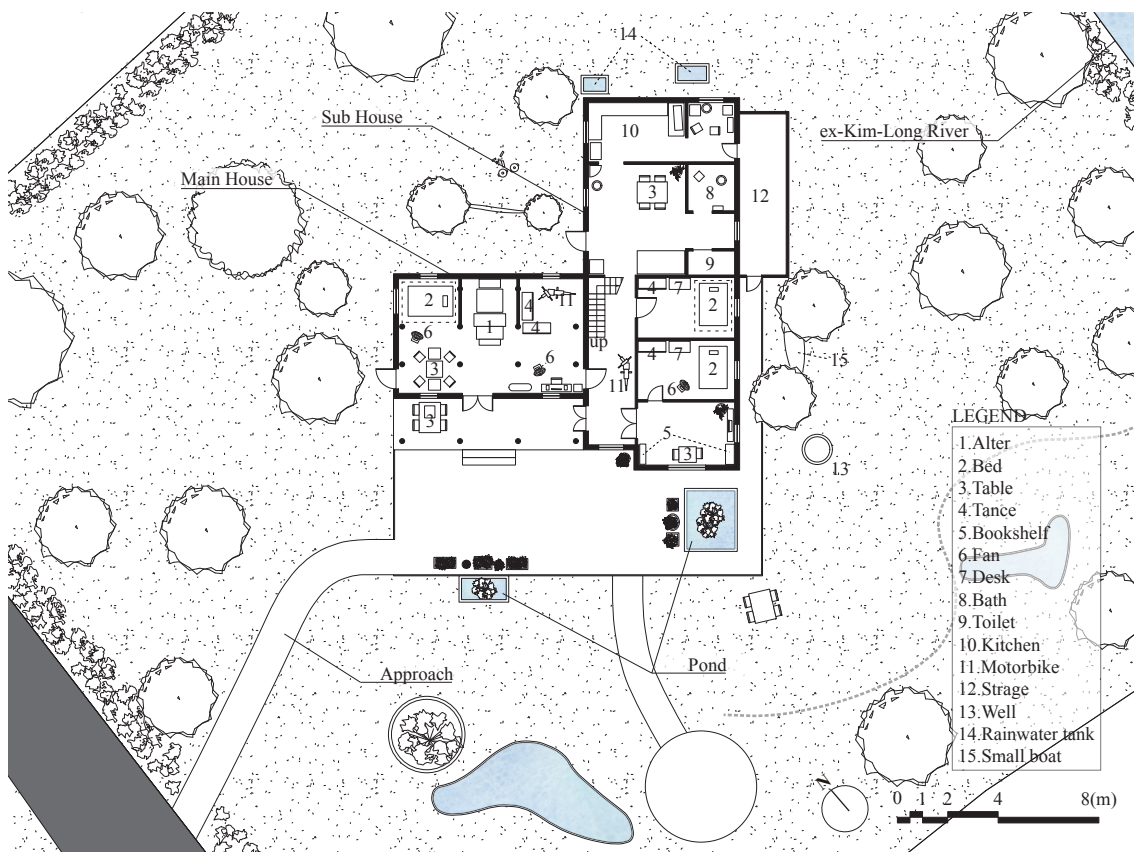


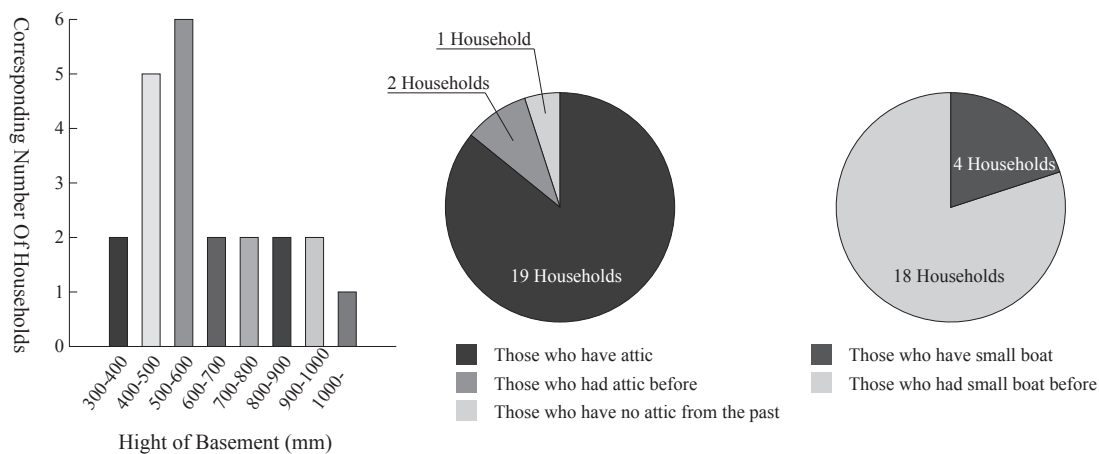
Figure 4-1: Example of Site Plan & Furniture Arrangement (Sample 19)

leveling the building foundation to prevent inundation above floor level, (2) making an attic as the indoor evacuation space, (3) preparing a small boat as means for evacuation (Table 4-1).

Although the basement of the Garden Houses in Kim-Long was generally leveled higher from 400 millimeters to 600 millimeters high, it could depend on each condition of location.

The attic was made as an indoor evacuation space, however 4 households living along the ex-Kim-Long River had small boats to take precautions against floods, in some cases of inundation where issues cannot be solved by evacuating to the attic space. As mentioned in 2-4-1, the area along the ex-Kim-Long River was vulnerable to floods; therefore local inhabitants living there were more careful about floods than inhabitants living in the other places in Kim-Long.

Table 4-1: Results of Interview about Countermeasures for Taking Precautions against Floods



4-4. Summary

In this chapter, 3 points were clarified as follows:

- As for indoor living environment, local inhabitants living in the Garden Houses answered that the traditional house is more comfortable than the contemporary one. They made use of spaces in the Garden Houses taking ventilation condition into account.
- As for outdoor living environment, wells and rainwater tanks which keep water from natural environment was used in the past. And a majority of the households used river water before, however they have a tenuous relationship with river due to the construction of the water-supply system and contamination of river water nowadays.
- There were the means to take precautions against floods which couldn't coped with only by the village location and the housing lots condition, as mentioned in Chapter 1 and 2. Besides, there were differences in ways of the countermeasures depending on each condition of location.

5. CONCLUSION AND PROSPECTS

5-1. Conclusion

In this study, it was defined that most of villages along the Huong River have been located while considering the flood damage mitigation and the geological feature in each region. However, the flood damage in Kim-Long has been getting more and more serious by 2 factor; 1) the changes of the forms of rivers at the construction of the Hue-Citadel and 2) the changes

of land use contributing to flood mitigation after Vietnam War until the present time in Kim-Long (Ch.2).

In addition, in process of subdivision of the housing lots in each dwelling associated with the changes of land use, although the main house location was taken into account basically, density growth of the dwellings was caused remarkably in the case of sale or transfer of a part of a housing lot to unrelated persons. Owing to that, bad ventilation condition and loss of the garden for rainwater infiltration were caused (Ch.3).

Meanwhile, local inhabitants have the measures to take a precaution against floods. However, that might be limited as long as there are changes as mentioned above (Ch.4).

5-2. Prospects

There are concerns that recent urbanization in Hue might cause a loss of the traditional culture of life. Thus, it is necessary for moderns to take the traditional village location and lifestyle into account for achieving the sustainable development and conservation of the traditional villages in the Huong River Basin.

Besides, although moderns have attempted to preserve the Garden Houses focused on tourism in terms of the traditional wooden houses, it should be desired that the Garden Houses are also preserved in terms that there are the sustainable ways of living together harmonized with the harsh water environment and the large gardens that have high potential to mitigate the flood damage by using the traditional technologies of environmental control.

Notes:

(1) Flood in 1999: The huge flood happened on November 1999, said to be the greatest one in the century. More than 700 people were killed by this disaster.

(2) Garden House: Especially in this study, the words are used to indicate a traditional house named “Nhà Luong” in Vietnamese. Its architecture and front yard are planned with considering the surrounding Feng-Shui conditions. A family altar is placed on the central axis inside the house.

(3) Feng-Shui: Philosophical system of harmonizing nature and humanity. It is considered to have been established with accumulating knowledge and technology through the history of planing cities and architectures following natural condition of their surroundings. It is originated from China but developed and applied in each region. Topography and orientation are the important elements.

(4) Subdivision of the Housing Lots: Action of subdividing a housing lot into some smaller parts. Making some concrete masonry walls on the boundary of a subdivided part and construction of new dwellings inside the housing lots are similarly considered as “Subdivision of the Housing Lots”.

(5) Đình: Religious architecture enshrining genius loci. It is built in each village in the north-central Vietnam. It is mainly used as a meeting place of community at present. There are 3 Đìnhs in the studied area: Kim Long Đình, Phú Xuân Đình, Vạn Xuân Đình.

(6) Flood Inundation Map: This map was made in 4 steps below: “Step 1: Develop a digital elevation model (DEM) from the collected GIS data. Step2: Compute water level using hydlogical/hydraulic models. Step 3: Develop water surface models WSMs. Step 4: Flood inundation maps are developed by using spatial analysis tools in GIS.” (Source: Reference 2))

(7) Natural Levee: Geographically high place in a floodplain, formed along a river by its erosion. It is well drained with being slightly higher than the backmarsh situated behind.

(8) Main House: The main architecture of Garden House which includes the family's altar on its central axis.

(9) Regulation on the Garden Houses by people's committee: Restoration, research and tourism for the Garden Houses are mentioned in the Decision No.1458 issued on 21th April 2005 by Thua Thien Hue Committee.

References:

- 1) Yukihiro Hirai, Nguyen Van Lap and Ta Thi Kim Oanh, Assessment of Impacts of Sea Level Rise on Tam Giang-Cau Hai Lagoon Area Based on a Geomorphological Survey Map, 2008, Regional Views, 21, p.1-8 (In English)
- 2) Pham Hong Nga, "Flood Hazard Mapping" Training Course & Follow-up Seminar,
http://www.icharm.pwri.go.jp/training/2007_pdf/nga_vietnam.pdf, latest access: 29th August 2014
- 3) The University Of Texas At Austin, Perry-Castaneda Library Map Collection,
http://www.lib.utexas.edu/maps/world_cities/txu-oclc-21740104-hue-1968.jpg, latest access: 29th August 2014
- 4) Phan Thanh Hai, The Nguyễn Lords' capitals in the Hue Culture and Formation of the Central Vietnamese Culture, 2012, Cultural Interaction Studies of Peripheral-Areas Series, Vol.7, 497-505 (In Japanese)
- 5) Phan Tuan An, Hue-Citadel, 1999, p.101 (In Vietnamese)
- 6) Le Ngoc Van and Fausto Pugnali, A Study of Climate Adaptation of Hue Traditional Garden House in Vietnam and the Application in Contemporary House, 2013, IACSIT International Journal of Engineering and Technology, Vol.5 No.1, p.5-9 (In English)
- 7) Nguyen Ngoc Tung, Hirohide Kobayashi and Masami Kobayashi, No.9 Ngo Thoi Nham Street: the evolution of a traditional garden house in Hue, Vietnam, 2012, SANSAT: An Environmental Journal for the Global Community, 6, p.65-84 (In English)
- 8) Kyoko Imamizo, Makiko Oka, Futoshi Hatakeyama, Katsutoshi Nonaka and Shigeru Sato, A study of urban transformation, in HUE-VIETNAM, Part 5 ~special composition of building type and architectural transformation inside the Citadel~, 2001, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, p.643-644 (In Japanese)
- 9) Futoshi Hatakeyama, Kyoko Imamizo, Makiko Oka, Katsutoshi Nonaka and Shigeru Sato, A study of urban transformation, in HUE-VIETNAM, Part 7 ~the prototype of the residential architecture and its transformation~, 2001, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, p.647-648 (In Japanese)
- 10) Soichi Fukazawa, Naoaki Furukawa, Hiroki Yamada and Shigeru Sato, A study of urban transformation, in HUE-VIETNAM, Part 11 ~the style of household separation and the transition of residential architectures as it changes~, 2004, Summaries of Technical Papers of Annual Meeting Architectural Institute of Japan, p.841-842 (In Japanese)