

# Identification of the Natural Elements for Sustainable Development in the Urban Structure of Vietnam: The Case Study of Hue City

Nguyen Hong Dung and Vo Ngoc Duc

**Abstract**—During urban formation from 1802 to 1945, the mountain systems and natural waters were closely utilised in urban design of Hue City which was a relevant example of urban planning for sustainable development. Hue Citadel was built as an unusual combination of human and nature, the principles of Western military architecture meeting the ideology of Eastern philosophy and traditional architecture of Vietnam. The fortification model of Sébastien Le Prestre de Vauban harmoniously united with local natural elements to create the identity of the ecological system which was considered as an appropriate local technology for environmental self-regulating.

In the last decades, Hue City has been experiencing main changes by the impacts of urbanization such as the increase in population, changing lifestyle, environmental pollution, flood, causing heavy variation of the characters of the traditional landscapes, and harming of the heritage. Most of the precedent designs and ideas tend to be ignored and broken down. Understanding and identification of characters of historical fabric, landscape value, and urban structure are very important to the preservation of a sustainable model which orients towards the Feng Shui methodology. Since 1993, the complex of Hue Monuments was inscribed on the List of World Heritage by UNESCO.

**Index Terms**—Identity, Feng Shui, ecology, water, sustainability.

## I. INTRODUCTION

Long time ago, in East Asian and Southeast Asian, there were very particular sense of environment, philosophy of environment. In the same way, the Vietnamese predecessor smoothly used philosophical ideas for design and urban planning basing on the natural elements. The idea of people and physical setting is belonging to the nature. Nature and human could exist there forever. Besides, from 1802 to 1945, Nguyen Dynasty also applied the Western military architecture for the constructive planning of fortification city from North to South in Vietnam with the thirty one citadels and small fortresses, following the model of Sébastien Le Prestre de Vauban (a French military engineer), commonly referred to Vauban style [1]. Nuclear and typical citadel was the Capital of the Nguyen Dynasty in Hue, was built since 1803. Before 1884, most of the urban expansions were

designed as the traditional oriental architecture with Feng Shui principles. Thereafter, when the French ruled, these cities were built with new types, import of materials, techniques and Western technologies.

The result of this process created an urban morphology which was respectful of the local natural and architectural identities, and provided a development model in harmony with traditional features and tropical climate, the urban model of sustainable development. A unique city mixed nature and human with existence and parallel development of both indigenous and colonial architecture. Consequently, Hue Citadel was the pinnacle of the art of architectural bastion, the harmonious combination of Western military architecture, Feng Shui principle and traditional architecture of Vietnam [2].

In the last decades, the development of urbanization in Vietnam made Hue City changing. There were a lot of impacts of urbanization such as the increase in population, changing lifestyle, environmental pollution, flood, causing heavy variation of the characters of the traditional landscapes, and harming of the heritage. In particular, after 1986 – the renovation period, market economy, land expansibility, etc. affected strongly traditional structure and landscape. Most of the precedent ideas tended to be ignored. The identities of the local place have been destroyed. Understanding the true meaning of original structure is very important for proposal a sustainable model in future.

Although some studies have reported regarding the investigation of the influence by the Vietnamese researchers, the Japanese scholars, however there is not yet plenary evaluation of the role of Feng Shui methodology; the harmoniously combinative idea between human and natural, geographical setting; the values of traditional urban structure of the predecessors. The paper focuses analysis the available natural elements and their application in the urban planning of Hue City from the predecessor towards aims of the sustainable development.

## II. MATERIALS AND METHODS

### A. Ecological Method

According to the universe opinion and human opinion of the ancient Eastern people, they were aware that there should be no antagonism between man and nature: "man-nature unification". This was the principle of Eastern architectural art thousands of years ago that humanity nowadays calls as landscape architecture. Base on natural geographies, Hue urban planning utilised surrounding natural resources and

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tropical climate to create a suitable living environment. For this reason, Huong River valley and Hue City could become an Asian role prototype for harmoniously economic development while emphasizing natural resources and historical heritages. The data of geographical survey is very useful to identify the true meaning of the Citadel's formation, ideas and geological condition behind its planning. There were two major elements: ecological principles of urban planning and water system. The urban planning closely involved in the local topographical structure, the flow of water and river, and the view to the mountains. Ecological technology adapted to local geography, water and wind. Canals and lakes were dug to fill the citadels. Huong River and waterway were connected for transportation and control flood, water level.

### B. Feng Shui Method

The unusual design of ancient Vietnam cities was created according to the Eastern philosophy. This idea was closely applied for Hue Citadel and also written down in some ancient books of Vietnam and China. In this context, the Feng Shui methodology was important mode and unique urban design in East Asia and Southeast Asia. It could be application for global environment in 21<sup>st</sup> century. By use of available natural elements, the Feng Shui method was strictly applied in choosing location, direction, layout of components. There were three main premises such as the Yin Yang theory, the Three Elements theory (God, Earth, Human), and the Five Elements theory (Metal, Wood, Water, Fire, Earth). The Feng Shui method suggested as front Screen, back Pillow, left Dragon, right Tiger, reassembling the water surface, and Ming-Tang element. Hue Citadel was a clear demonstration of the application of the Feng Shui for creating a city.

### C. Situation Survey

The processes of situation evaluation have been carried out for several years from 2002 with different times. The survey data based on historical documents, maps, measurement, archival research and interviews which aims to document the changes, as destruction of monuments and ecological structure of urban landscapes of Hue after 1945 (national independence), 1968 (Mau Than War), 1975 (national liberation), 1986 (renovation period). Besides, the situation survey materials of Hue Citadel - Waseda University - Japan, Polytechnic University of Marche - Italy, Hue Monuments Conservation Center, and Faculty of Architecture of Hue University of Sciences - showed us the structure of natural ecosystems, habitats changes, and the activities of the local people.

## III. RESULTS AND DISCUSSION

### A. Idea and General History of the Formation of Hue City

Hue City is in the middle of Vietnam, the capital of Nguyen feudal Dynasty from 1802 to 1945, it was not only the political but also the cultural center of Vietnam. After the feudal Dynasty, the Vietnam Wars made this capital changing a lot such as the identities of the city, ecological system, and lifestyle. In 1993, the Complex of Hue Monuments was on the List of World Heritage by UNESCO.

Before 1802, Hue urban space was chosen strategic position carefully by the many Nguyen lords. In 1687, the lord Nguyen Phuc Thai chose Phu Xuan village as political center in Annam, established the metropolis. Then in 1738, the lord Nguyen Phuc Khoat constructed more to be a capital. In 1788, Nguyen Hue, after taking the throne, took Phu Xuan as the united capital. From that time, the Nguyen lords had intentions and ideas, applying natural elements as rivers, mountain to the organization of urban space for formation of Hue urbanism nowadays (Fig. 1).

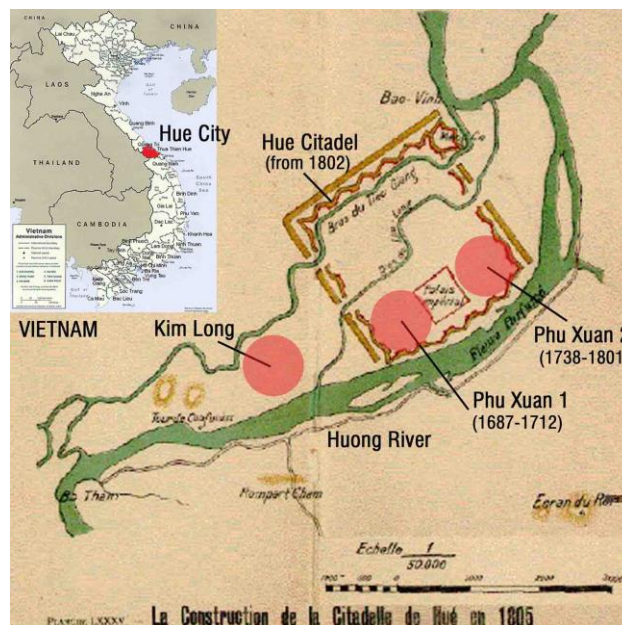


Fig. 1. History of the formation and transformation of Hue city [1].

Fig. 2 shows historical process of the formation of Hue Citadel associated with four periods:

- Period of construction and completion of Hue Citadel (1802 – 1832): Citadel - ramparts, defensive water moats - followed the type of the Western military, while the two inner ramparts - the Imperial City and the Forbidden City were built according to the style of ancient oriental architecture. In the process of formative rampart, one of the lands which was trenched from the outside moats used to build the rampart. The relationship between rampart and defensive rampart is inextricably linked with each other. During process construction of Hue Citadel (1805-1832), the water moats were entrenched with Rampart at the same time. Following the Nguyen historical document said that:

“The Citadel was built on the date of Quy Mui. Four sides of the ramparts are 2.487 meters in length 4 meters in height 7 meters in width; four sides of the moats are 2.503 meters in length, 4 in height, 7 meters in width etc.”[3]

Or historical document of Đại nam nhất thống chí also said:

“The perimeter of moat is 19 meters in length, 7 meters 5 in width, 1 meter in depth. All the gates of moats have the stone bridges” [4]

The system of rivers, lakes were also built at this time inside the citadel. The Feng Shui principles were closely applied in direction, location and layout of construction.

- Period of consolidation and development of Nguyen Dynasty (1833 – 1883): development and expandability

according to traditional Vietnamese architecture inside Hue Citadel. House and garden were always closely, layout arranged the spaces with axial orientation, facing to a good direction (south or southeast). The identity of urban morphology were pressed the characters creating the unique citadel.

- Period of domination and invasion by the French colonialism (1884 – 1945): under the protectorate of the French, the period of the combination between of traditional architecture and the import of new materials and construction techniques of the West. Beside the old urban area in the north of the Huong River, there was an additional garden villa system in the south, with its form and function in harmony with the old architecture and adaptation with tropical climate in Hue.
- Period from 1945 up to now: the period of change due to the strong impact of the war, people and nature. After 1975, it was an increase in population, land encroachment and redevelopment of habitat that extended to the south of the city. Some rural areas were freely formed in small points in the sea, plains, and mountains.

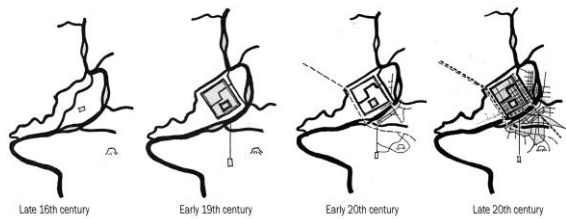


Fig. 2. The formation and transformation of morphology in Hue city [5].

### B. Situation Use of Land and Surface Water in Hue Citadel after 1945

Nguyen Dynasty came to end in 1945, and then Vietnam experienced the wars against the French (1945-1954), the American (1955-1975). In this context, the Hue Citadel became the place where people escaped ammunition, the war quickly changed the urban form of the capital city. There were a lot of royal heritages and traditional houses destroyed seriously such as Luc Bo, Tan Mieu, and Thuong Mau Vien. In addition, many small roads were made the area of the Hue Citadel divided into many plots of varied shapes and scales. After 1975, Vietnam became a united country, a large number of immigrants entered the city for living and built their houses in different types, even there were the houses was built on the rampart. After all, that has made a great variation on the morphology of the Hue Citadel.

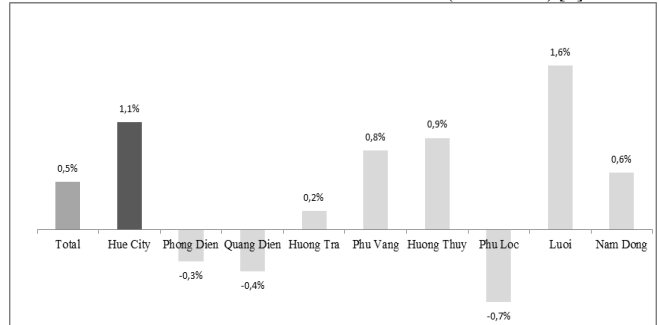
In the last decades, Hue City has experienced main changes by the effect of urbanization such as increase in population (Table I), changing lifestyle, environmental pollution, flood, and the land encroachment, etc., causing heavy variation of the characters of the traditional landscape, and harming of the heritage.

The survey data show that a part of the residents living around water moat, lake system, Ngu Ha river and upon the rampart are formed (Fig. 3), the activities of people are include: doing exercises, walking, resting, daily activities, agricultural mining, animal poultry, livestock, trade services,

festivals, tourism, etc. With frequency, the variety of forms of human activity has become an indispensable part of everyday life of people of this area, because of their living as well as their income. In such activities, the water encroachments are occupied everywhere to grow vegetables, and drop dirt. Especially the discharge of domestic waste, activities of local people cause serious environmental pollution and unsightly things, adversely affecting the visual aesthetics of urban, etc. (Fig. 4).

In addition dam construction of the plot takes place continuously that causes the moat surface getting dry, the manhole congestion of water controls function of Citadel water system, the encroachment of people are breaking traditional landscape structure, harming the system rampart and water. The Fig. 5 shows the evident changes and expandability of land use of Hue City between 1885 and 2015, house density more increases by the time.

TABLE I: ANNUAL AVERAGE RATE OF GROWTH POPULATION IN DISTRICTS AND CITY OF THUA THIEN HUE PROVINCE (2007-2011) [6]



Encroachment of Citadel

The emission of polluting activities

Fig. 3. The land use exiting around Citadel and lake.

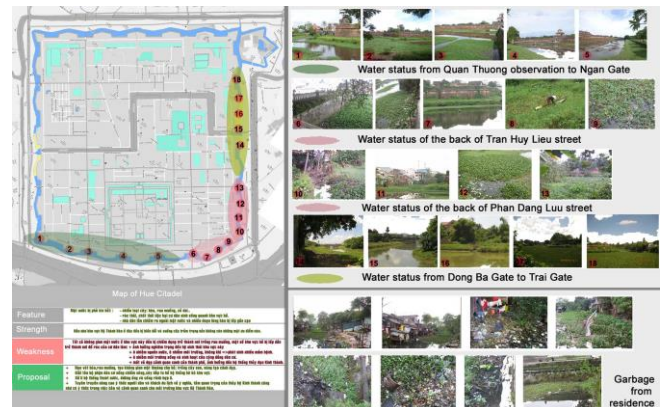
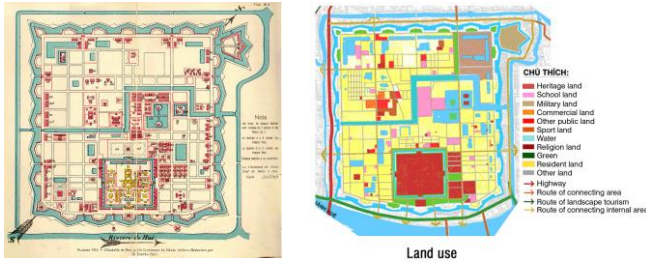


Fig. 4. Situation of surface water around Citadel in 2015.

Besides, the natural disasters also cause the changes. The basin of Huong River has shortly slope with highly-concentrated rainfall and high flood frequency. Hue City is affected heavily by flood. According to the water level data at Kim Long station duration 27 years 1977-2003, there



were 33 flood events, which top water level was higher than 3.0 m (Le Loi street along Huong River is 3.2 m); 10 flood events, which top water level was higher than 4.0 m; 5 flood events, which top water level was higher than 4.5 m. These monthly distributed in the Table II.



Use of land in 1885 [1] Situation of use of land in 2015  
Fig. 5. The situation of use land of Hue Citadel in 1885 and 2015.

TABLE II: MONTHLY DISTRIBUTED FLOOD EVENTS IN HUONG RIVER (1977 - 2003) [7]

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Events												
H>3.0 m	0	0	0	0	1	1	0	1	5	14	10	1
H>4.0 m	0	0	0	0	1	0	0	0	1	6	2	0
H>4.5 m	0	0	0	0	0	0	0	0	0	4	1	0

Through time, the impacts of history, human and nature, have made the ecological and water systems of Citadel changing a lot, led to the transformation of the original function, seriously effect on the lives of residents as well as the conservation of architectural heritages in this region.

#### IV. IDENTIFICATION OF THE NATURAL VALUES FOR SUSTAINABLE STRUCTURE OF HUE CITY

##### A. Hue City in General Structure of Territory

There are the varieties of territory with the features of the tropical climate, and complex territory such as the mountain systems on the west, the variety of the topography; the marine systems, lagoon system and sand dunes on the east; the plain in center with many rivers, lakes and diverse eco-system, etc. (Fig. 6-7). The predecessor designed Hue City as an urban center combining tightly with natural condition to create identity of a model of sustainable development.

**Topography:** Hue is located on a narrow plain and has steep terrain from west to east. Hue City is formed in the center of the narrow plains of the lower section of the Huong River with two types of topography (Fig. 8):

- Low hilly topography is eroded and developed on sedimentary rocks, distributes in the west of Hue City, in Thuy Xuan and An Tay district.
- Topography of the plains distributes in the north and east of Hue City, divides into two main areas: northern Huong River and southern Huong River. The northern Huong River area is flat with the citadel has from 1.8m to 3.5m in height. The southern Huong River has an altitude from 2.5 m to 7.5 m in height, particularly with some hills are from 12m to 18m high, fields and ponds are less than 1.5m high.

**Climate:** climate changes are large fluctuations and characteristic with monsoon humid tropic. In hot and dry season (from May to September), the heat of the city is quite

high, with the effect of southwest wind, making the air become very dry. The average temperature in the summer months is 27-29°C, the hottest month (May, June) the temperature can reach 38-41°C. During cold and rainy season (from October to April), the effect of northeast monsoons, heavy rain, average temperature is 20-22°C. The rainfall is the largest in the country, the annual average rainfall is 2,800mm. However, the rainfall is unevenly distributed and concentrated in the rainy season, especially in October and November (Table III and IV). Climate characteristic makes drought in dry season and flood in rainy season.

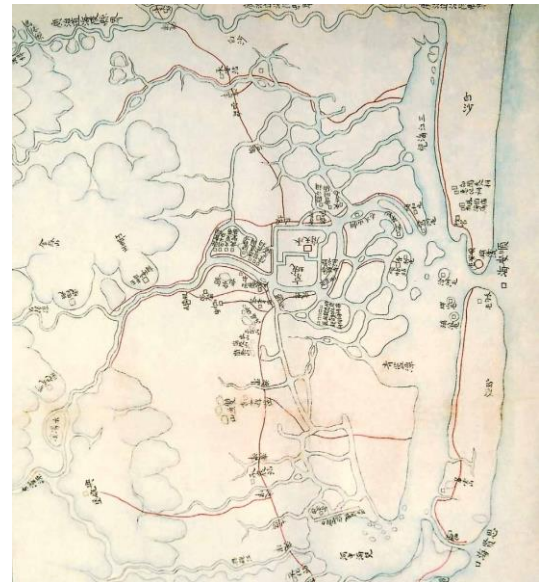


Fig. 6. Maps of mountain system, river and lagoon system in Hue territory (source: The Descriptive Geography of the Emperor Đồng Kh ánh).

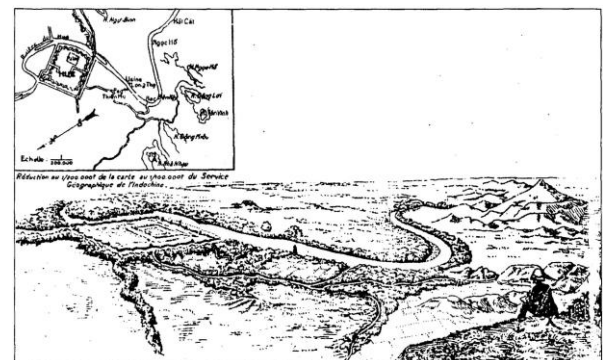


Fig. 7. Overview of Hue territory from the west of Citadel [1].

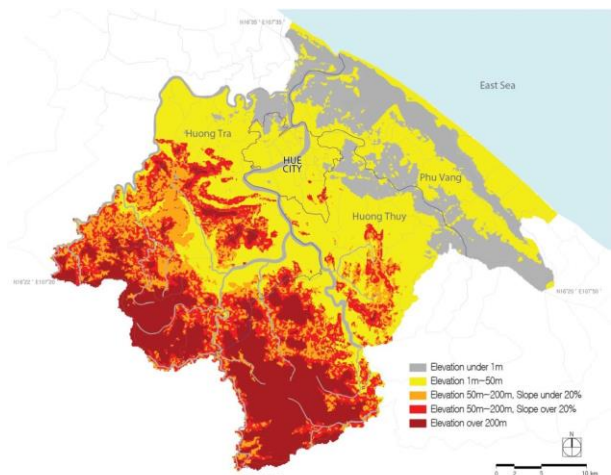
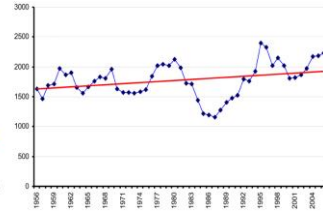


Fig. 8. Maps of some available natural elements of Hue city [6].

TABLE III: CHANGING TREND OF AVERAGE RAINFALL IN JULY [8]



TABLE IV: CHANGING TREND OF AVERAGE RAINFALL FROM SEPTEMBER TO NOVEMBER [8]



**Hydrology:** Hue City is directly affected by Huong River hydrographical regime. The Huong River consists of three branches: Bo River, Ta Trach River and Huu Trach River, originating from the mountain slopes of the Truong Son mountain and flowing through Hue City. This river has a basin area of 2,830 km<sup>2</sup>, accounting for 56% of the total area of Thua Thien Hue province, 104 km in length. Besides, the southern area of the Huong River has branches of An Cuu, Nhu Y and Phat Lat rivers, connecting to form a complete natural drainage network. The northern area of the Huong River has Bach Yen, An Hoa, Ngu Ha, Ho Thanh Hao rivers and lake systems, making a flood control systems for the capital.

According to the predecessors, the soft solutions were applied to preserve and protect Hue City. Hard engineering solutions are always expensive, and require additional. Rice, farmland, and rural villages in between the citadel and the coast would be given over to development in general territory. This direction provides an appropriate buffer area around the historic monuments. This approach to development raises several long term. While people have supported in this environment for centuries, Hue City is located significantly inland which has likely always been more resilient to flooding. It can be argued that the form of original city has in the past helped people to cope with natural disasters. With rice and other agricultural areas on unstable land provide natural flood plains for waters to collect, and wetlands have function as natural sponges outside city center. In history, people who did live in the lagoon lived in temporary structures that would often allow for quick recovery after disaster (Fig. 9, 10, and 11). The idea of Ecological function zoning of urban economy could be applied for the city such as human ecological zone, ecological agriculture development area, ecological and economic coordination and development zones, and cultivating ecological protection zone [9].

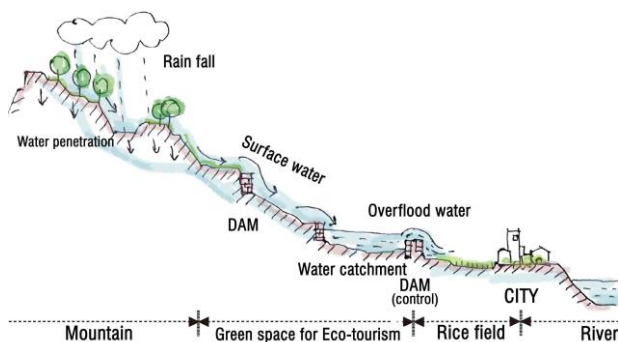


Fig. 9. Topographical section of control of the water system for environmental self-regulating from west to east.

In the same direction, the Koica project of Modification of

Hue City's Materplan 2030 and Vision 2050 is also applying this idea (Fig. 12). Adaptive living with inconvenient natural elements could be a good way for a sustainable development model in future. Sustainable development is "as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs." [10]

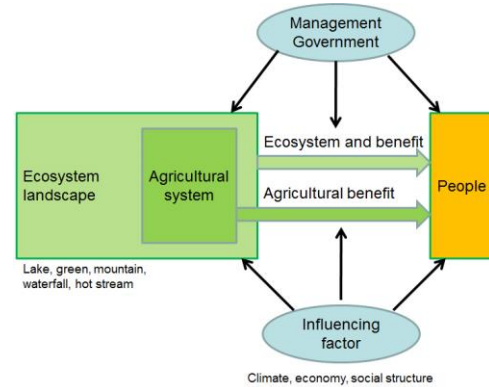


Fig. 10. Proposal of people activities from the natural conditions for economical enhancement.

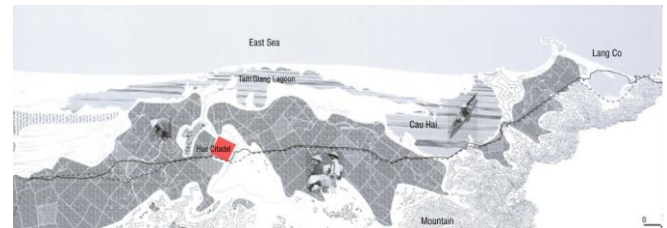


Fig. 11. A proposal of Hue's urban agriculture and water production [11].

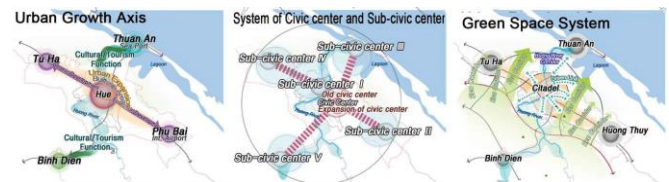


Fig. 12. Proposal of urban center structure and hierarchical satellites for Hue City [6].

### B. Feng Shui Principle

From the beginning, Nguyen Dynasty was specially interesting in the principles of traditional architectural planning in particular and the ideology of Eastern philosophy in general. Those were the architectural planning criteria, which based on the Feng Shui methodology, being a key idea in the general planning of the architectural layout of Hue Citadel. The position, direction and layout of components of Hue Citadel were carefully selected, containing full geographical features such as rivers, mountains, plain and special natural features. The historical book records that early 1687, when the land of Phu Xuan village was selected first time to establish the capital of Annam, the architects of urban planning designed as "Use the mountain in front (i.e. Ngu Binh Mountain) as a Screen, fill up the wall, build a palace, dig in front of a large lake etc." [3]. According to the Feng Shui principle, Huong River and Ngu Binh Mountain as front Screen for Citadel, two small islands were two factors left Blue Dragon and right White Tiger, forming general space of Hue urban Masterplan (Fig. 14).



The predecessor used a compass which has several concentric circles having the symbols of the Eight Trigrams (Bá quái) to find a good position and orientate a good direction (Fig. 13). Moreover, the idea of axis towards mountain was also applied closely to the design in Royal Tombs and Temples in the west south of Hue City (Fig. 15).

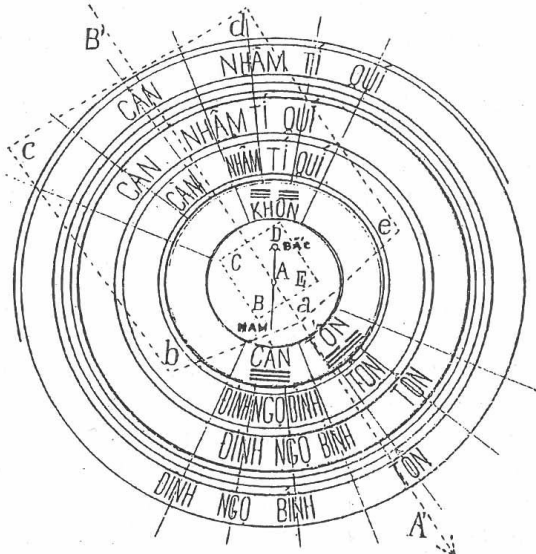


Fig. 13. Scheme of La Kinh (compass) for the indication of good direction [12].

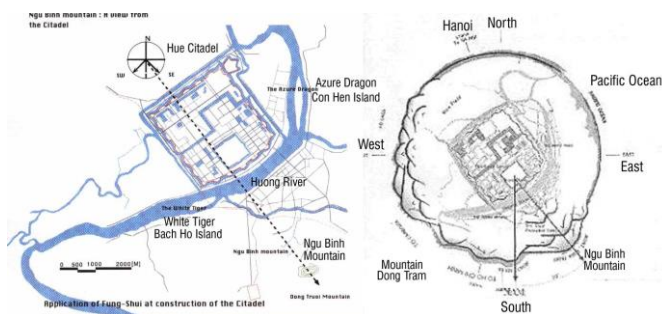


Fig. 14. Main divine axis and relationship between Hue Citadel with special natural elements [13].

The position and direction of city according to this choice creates a sustainable model which harmoniously adapts to the natural resources. “Feng Shui means make the most of the influences of wind and water, understanding nature” [14]. This solution enhances the convenient elements and reduces the disadvantage from natural conditions such as sun, wind, rain, etc.

### C. Structure of Hue Citadel

Hue was the imperial Capital of the Nguyen feudal dynasty from 1802 to 1945. Hue urban structure was closed utilised with the system of mountain and natural water. The Citadel location fronted Huong River with convenient water transportation, surrounding mountains for easy protection. Hue Citadel was built from inside to outside including: the Imperial City, Forbidden City build (09/05/1804), and Citadel build (28/05/1805). The Citadel was 520 hectares in area. The rampart system with several major buildings was built on a same axis. “Outside the citadel wall, there is a moat system; which encompasses surrounding. In addition, a system of river Ho Thanh Ha, which covers the citadel on the left, right and rear sides, then fall to Huong River in front of the citadel”

[15]. In this period, the Huong River became the main transportation, their artificial and natural branches became secondary routes using in order to identify the inside area of the Citadel. These river branches, which flowed through the Citadel, combined with a lot of lakes and trees in this area, creating the system of ecological landscape, self-regulating water flow and habitat of local residents.

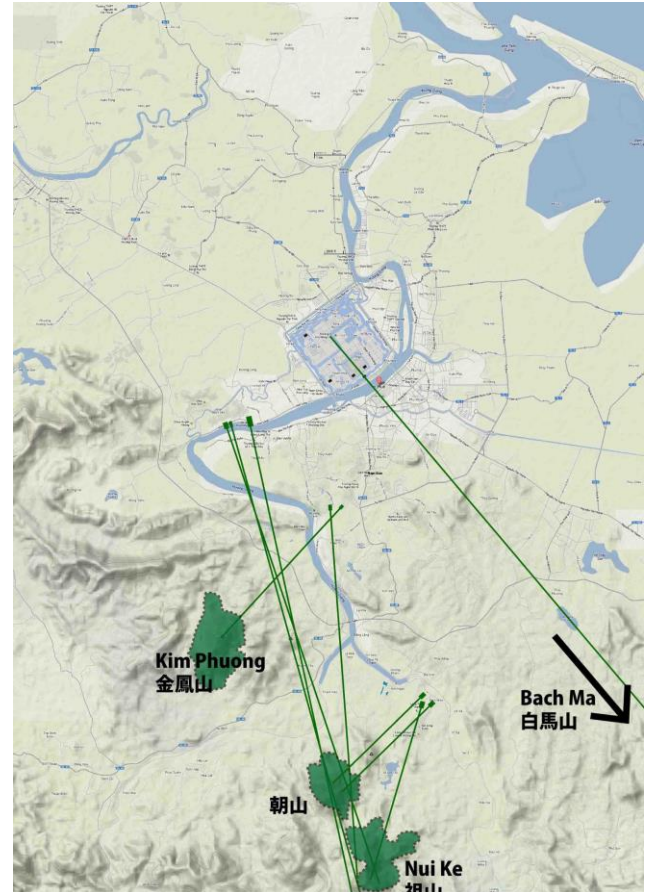


Fig. 15. Main divine axis and relationship between Hue Citadel, Royal Tombs with special natural elements (source: Waseda University).

Citadel architectural solutions were organized in harmony with natural landscape. The compositions of architectural space in garden house, royal palace were dispersed in layout, several architectural layers which interwoven with green, water. The spaces tended to horizontality, spreading, flexibility, creating the ventilation for building by patio, garden, outside long corridor, joining bridge, lake, etc.

### D. Water System

Water system in the Citadel is formed by three main systems of water: Ho Thanh Ha moat, Ngũ Ha River, and the system of forty eight lakes inside the Citadel. Some important lakes are located in districts of Thuan Loc, Thuan Hoa, Tay Loc and Thuan Thanh, they are Tinh Tam lake, Hoc Hai lake, Sen lake in Thuan Loc district; Vo Sanh lake, Tan Mieu lake in Thuan Hoa district; and Moc Duc lake and Huu Bao lake in Tay Loc district. The canals and the lakes were not only made from the dig to fill the ramparts, but also created ecological water. Besides, surrounding moat system of the Citadel has the inside Kim Nguu lake and outside Kim Ngu lake. These four rivers are linked together to make a flow of water of the Huong River to regulate drainage of the Citadel (Fig. 17). Thus, the water from raining season can be collected and



reserved in the lakes and when flood, the excessive water could run to Huong River, lagoons, fields as buffer areas which would help drain the water and preserve the water in drying season (Fig. 16, 18 and 19).

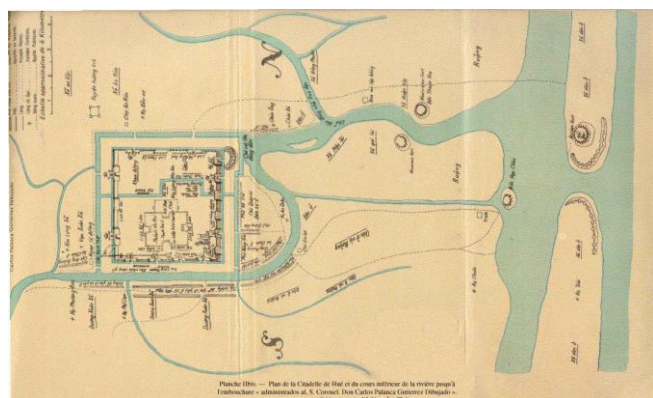


Fig. 16. The circulation of the water system of Hue Citadel with river and lagoon from Nguyen Dynasty [1].

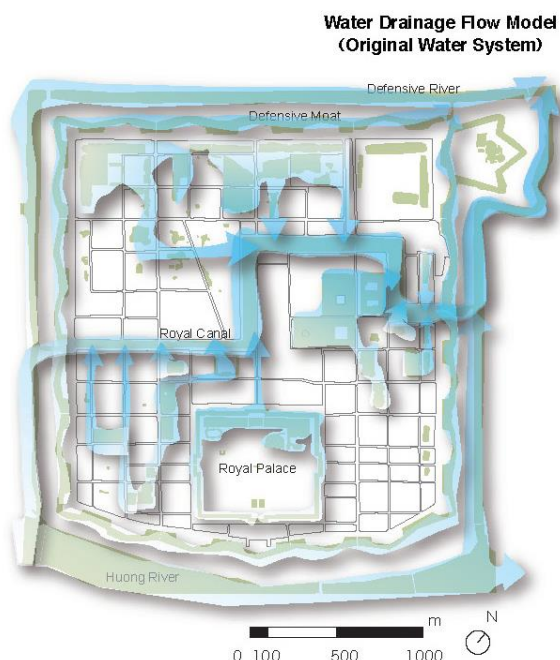


Fig. 17. The connection of the water system in Hue Citadel (source: Waseda University).

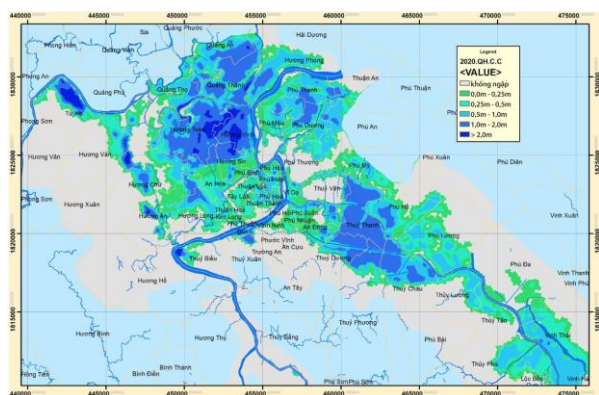


Fig. 18. The flood map in Hue in 2020, the case study of absence of regulation of the water reservoir [8].

The water system of Citadel was a diverse ecosystem which played a very important role in protecting the environment, regulating the water system in the Citadel. Formerly the Huong River and the underground waterway were connected.

It can be that the water control created in Nguyen Dynasty is very useful for the regeneration of the historical environment. This is the proper soft engineering solution as an appropriate local technology for environmental self-regulating.



Fig. 19. Overview of Hue Citadel (source: VinGG).

## V. CONCLUSION

Over time, the urban structure of Hue City has confirmed its value through the process of the formation in scale, structure and urban morphology. It is very important to understand the identity of the historical fabric, landscape value, and urban structure. The ecological landscape of Nguyen Dynasty has been demonstrated sustainable capability for the future. Through the paper, the authors want to bring out a new approach, using the technology and model of traditional urban planning in the conservation and enhancement of urban architecture of Hue City for the strategy of sustainable development.

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