

URBAN MORPHOLOGICAL TRANSFORMATION OF RIVERFRONT COMMUNITIES IN THE NAKHON CHAISRI BASIN, THAILAND¹

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บทคัดย่อ

บริเวณลุ่มน้ำนครชัยศรี จังหวัดนครปฐม ประเทศไทย เป็นช่วงที่แม่น้ำท่าจีนไหลผ่านจังหวัดนครปฐมใน 3 อำเภอ ได้แก่ บางเลน นครชัยศรี และสามพราน เป็นบริเวณที่มีความอุดมสมบูรณ์เหมาะแก่การตั้งถิ่นฐานและการเพาะปลูก รวมทั้งมีความสะดวกในการคมนาคมทางน้ำ จึงเกิด “ตลาดชุมชนริมน้ำ” ขึ้น ซึ่งเป็นศูนย์กลางของชุมชน มีลักษณะเด่นของ “สังคมลุ่มแม่น้ำ” ที่มีทั้งชาวนา ชาวดาน ชาวบ้าน และชาวตลาดพึ่งพาอาศัยอยู่

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ด้วยกัน ในเวลาต่อมา ชุมชนดังกล่าวได้เจริญขึ้นเป็น “ชุมชนเมือง” งานวิจัยนี้จึงมีวัตถุประสงค์เพื่อศึกษาและวิเคราะห์พัฒนาการเชิงสัณฐานของชุมชนเมืองริมน้ำในพื้นที่เกษตรกรรมแห่งนี้ ด้วยแบบจำลองเชิงสัณฐาน ตามแนวคิดสัณฐานวิทยาเมือง ซึ่งจำลองรูปแบบโครงข่ายการสัญจร และพื้นที่ว่าง จากแผนที่ทางภูมิศาสตร์ ประกอบกับการสำรวจพื้นที่ การสัมภาษณ์ และเอกสารสำคัญที่เกี่ยวข้อง แล้วเปรียบเทียบความเปลี่ยนแปลงจากอดีตถึงปัจจุบัน ผลการศึกษาพบว่า พื้นที่ที่มีพัฒนาการสำคัญ 3 ช่วงเวลา คือ 1) ยุคไร่-นา-สวน โอบล้อมชุมชนริมน้ำ (พ.ศ. 2401-2500) 2) ยุคชุมชนเมืองขยายตัวรุกกล้าไร่-นา-สวน (พ.ศ. 2501-2535) 3) ยุคชุมชนเมืองกระจุกกระจายไร้ทิศทาง (พ.ศ. 2536-ปัจจุบัน) ปัจจัยสำคัญที่ทำให้เกิดการเปลี่ยนแปลงของระบบนิเวศและสัณฐานเชิงพื้นที่ คือ การตัดถนนและการเพิ่มขึ้นของสิ่งก่อสร้าง และยังพบว่า บริเวณตลาดชุมชนริมน้ำที่เจริญขึ้นเป็นชุมชนเมือง มี 3 พื้นที่ ได้แก่ บริเวณตลาดบางเลน อยู่ในอำเภอบางเลน บริเวณตลาดท่านา อยู่ในอำเภอนครชัยศรี และบริเวณตลาดสามพราน อยู่ในอำเภอสสามพราน ทั้งนี้ บริเวณตลาดท่านาได้เกิดกระบวนการกลายเป็นเมือง (urbanization) มากที่สุด เนื่องจากมีศักยภาพการเข้าถึงสูงด้วยโครงข่ายการสัญจรทางบก ร่องลงมา คือ ตลาดสามพราน และตลาดบางเลน ตามลำดับ จึงมีข้อเสนอแนะในการวางแผนเชิงพื้นที่ โดยให้มีการควบคุมการเปลี่ยนแปลงรูปแบบการใช้ประโยชน์ที่ดินอย่าง

เหมาะสม เพื่อคงไว้ซึ่งพื้นที่เกษตรกรรมที่มีความสำคัญของประเทศ

Abstract

The main objectives of this study were to analyze the urban morphological transformation of riverfront communities in agricultural areas in the Nakhon Chaisri river basin based on a spatial configuration model following the Theory of Urban Morphology and to compare their transformations from the past to present. The theory of urban morphology was used to create a pattern of transportation networks and open spaces on geographical maps; moreover, a field survey, interviews and a review of related literature were included. According to the analysis, the basin has undergone three noticeable phases of development as follows: 1) plantation-rice field-orchard areas encompassing the riverfront communities (1858–1957), 2) urban communities taking over plantation-rice field-orchard areas (1958–1992) and 3) urban sprawl (1993–present). Construction of roads and more buildings is the main reason for a change in the ecology and the spatial configuration of this area. Furthermore, three riverfront community markets – Bang Len in Bang Len District, Tha Na in Nakhon Chaisri District and Sam Phran market in Sam Phran District – have been transformed into urban communities. Tha Na market is the most urbanized due to its easy access to the land transportation network, followed by Sam Phran market and Bang Len market, respectively.

Introduction

The early settlements in the Central Plains of Thailand were located along the river since settlers needed water for their daily lives and agricultural practices. Although some lived further inland on high ground, they drew water from the river through the system of canals. Serving as a major means of transportation, the river was a venue for exchanging produce and other goods (Valipodom 2011). Between 1855 and 1910, many canals were dug to facilitate the expanded agricultural areas and the transportation of produce, especially rice and sugar cane for export. Many natural rivers and canals were crisscrossed by these dug canals (Bunnag et al. 1982), resulting in many nodes along the main rivers, canals and trails. Later, communities were formed along these nodes and became resting areas for boats and goods before there were further developed into markets or small trading points for goods from boats and land vehicles. Then the markets were relocated on land and named waterfront community markets (Figure 1). These markets consisted of wooden row houses or indigenous shophouses used for commercial and residential purposes (Figure 2) (Panin and Jiratatsanakul 2001). Boats of various sizes travelling along the rivers were a common scene and traders from many areas would bring their own goods to be sold on the rivers; eventually floating markets emerged. As markets expanded, more houses were built generating a village and later a sub-district, a district and an urban community. Such an urban community differs from other urban communities in that it is a

*Urban Morphological Transformation of Riverfront Communities
in The Nakhon Chaisri Basin, Thailand*

center of land and water transportation and its spatial transformation keeps evolving because the build-up of sediment forms new land and at some point the river meanders or changes its course. At first,

this new land is a flood plain but later it becomes high ground. These are unique features of a city located on a river basin (Valipodom 2000).



Figure 1 Riverfront Communities in the Central Plains of Thailand (by the author 2014)



Figure 2 Atmosphere of a Waterfront Community Market (by the author, 2014)

The Nakhon Chaisri river basin, a fertile area of the lower Central Plains, is located between the Chao Phraya River and the Mae Klong River and is a tributary of the Tha Chin River, which flows through three districts of Nakhon Pathom Province – Bang Len, Nakhon Chaisri and Sam Pran – before emptying into the Gulf of Thailand in Samut Sakhon Province. This 97-kilometer-long Nakhon Chaisri River covers an area of 1,122 square kilometers (Figure 3), most of which is a flood plain. More than 200 natural and dug canals are found here; consequently, this area is ideal for agricultural purposes since there is enough water to satisfy needs. However, the kinds of plants grown vary according to ecology

and topography. In Sam Pran district, fruit trees are most common, while in Bang Len district, paddy fields are prevalent. In Nakhon Chaisri district, the ratio of paddy fields to orchards is about the same (Pornsiripongse et al. 2008). (Figure 4) Agriculturalists have to learn how to draw and store water for their own use. (Figure 5) This is another characteristic of a riverine society. The community center or market is surrounded by the agricultural area (Valipodom 2012). Agricultural products and handicrafts from nearby areas are sold in the market and middlemen come to buy these products to sell them in Bangkok (Pornsiripongse et al. 2008).

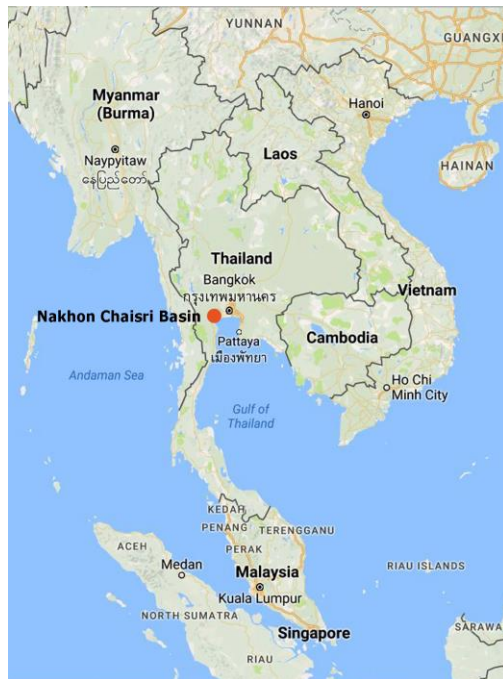


Figure 3 The Nakhon Chaisri Basin in the Central Plains of Thailand (Google map devised by the author 2014)

*Urban Morphological Transformation of Riverfront Communities
in The Nakhon Chaisri Basin, Thailand*



Figure 4 Agricultural Areas in The Nakhon Chaisri Basin (by the author 2014)

Many waterfront community markets sprang up during the reigns of Kings Rama V, IV and VII (1868–1934). According to an investigation of historical documents and old maps from 1913, there were many waterfront community markets along the Nakhon Chaisri River (Source: The Royal Thai Survey Department). Most of the markets still exist today, and while some did not appear on those maps, there is evidence of their existence. It can be assumed that these markets appeared after the maps had been completed. During that time, transportation was chiefly by water, and in 1942, when the Supan Transportation Co. Ltd. began its boat services from waterfront community markets in Supan Buri Province to Ngio Rai pier in Nakhon Chaisri district, where Ngio Rai Train Station was situated, water transportation became even more important. People would take a train to Bangkok from that station and get off at Bangkok Noi Train Station (Thon Buri), which became a market (Chompunich

1994). In Nakhon Pathom Province, there were seven waterfront community markets in Bang Len District, the most of all three districts, followed by three markets in Nakhon Chaisri District and two markets in Sam Pran District (Survey 2014) as shown in Figure 5. The number varied because of the topography, the density of canals, the distance from each canal to each land route and the fertility of the land. (Figure 6) Bang Len District is not far from the Gulf of Thailand, facilitating the transportation of people and goods to major rivers; as a result, there was greater circulation of people and goods in this area, resulting in the emergence of more waterfront community markets that have gone on to be transformed into urban communities, while the other two districts are flood plains with more winding rivers (Pornsiripongse et al. 2008). This has discouraged the establishment of waterfront community markets.

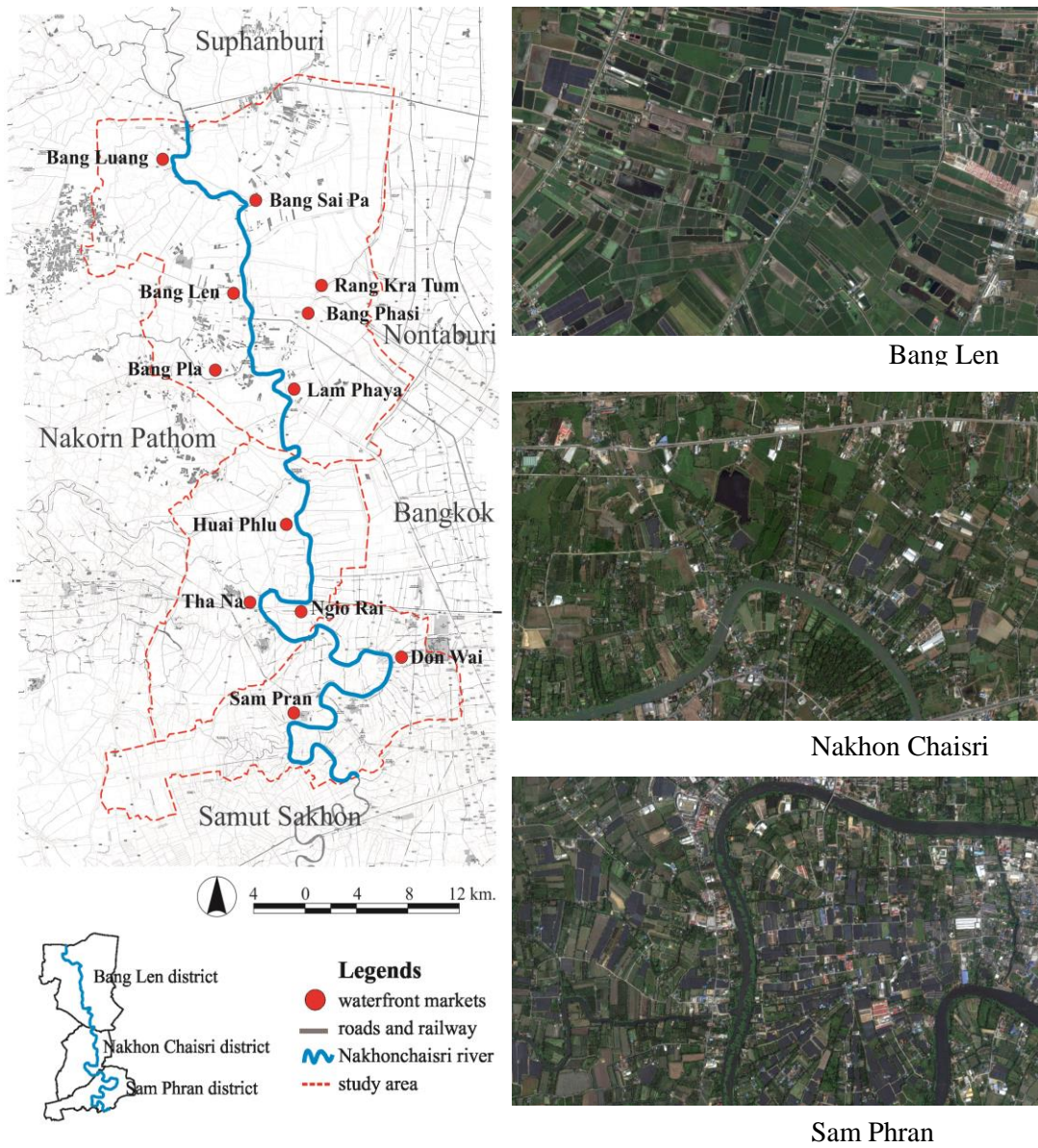


Figure 5 The Waterfront Community Markets along the Nakhon Chaisri River (Survey 2014)

Figure 6 Urban Morphological Characteristics of three districts (Google map 2014)

*Urban Morphological Transformation of Riverfront Communities
in The Nakhon Chaisri Basin, Thailand*

Water management for agriculture, daily activities and transportation of goods through the river network has played a major role in the settlement of the river basin, shaping a distinctive spatial configuration that carves the shape and form of each community and city. These shapes and forms can be compared based on the urban morphology through public space networks or transportation networks; in other words, the relationship between the public space network and the land or water transportation networks depends on the frequent use of such networks (Paksukcharern 2005). If the network is very well connected, more activities are carried out there than in less well connected networks; this means that, the density of passageways generates a lot of activities, most of which are commercial. On the other hand, a less well connected network generates fewer activities. A lower density of passageways is usual in an area that requires tranquility or some activities that do not depend on a large amount of mobility (Hillier 2000). The public space reflects people's ways of life there (Jones and Larkham 1991). This is in line with the concept "Social Logics of Space and Spatial Logics of Society", describing a society as being able to influence the spatial order and spatial management, and this makes that society unique (Hillier and Hanson, 1984). In addition, The road network is a key guide in urban development (Kasemsook et al. 2007). Changes in the land and water transportation and space are crucial to the shapes, forms and directions of expansion as well as the spatial change of an urban community.

The transformation of an urban community from a waterfront community market in the

Nakhon Chaisri river basin is considered extreme, especially after the introduction of the first National Economic and Social Development Plan (1961–1966). Under this plan, Nakhon Pathom Province came under the jurisdiction of the Bangkok Metropolis, leading to further road construction. Major roadways are Petchakasem Road connecting Bangkok with other provinces in the South of Thailand and Borommaratchachonnani Road connecting Bangkok with the Nakhon Chaisri river basin. In the past, people commuted by boat or train but after the completion of the road network (Chompunich 1994) the spotlight moved away from some waterfront community markets; however, some have developed into urban communities, and surrounding agricultural areas have been used for other purposes – residential areas, factory sites, roads or locations of offices. The importance of rivers and canals has lessened as some of them have been filled as and others have never been dredged so they are difficult to travel along. Dikes are seen in some parts of the canals, posing another problem for those commuting along them. This affects the way of life that residents are used to (Pornsiripongse et al. 2008). Under these conditions, the urban morphological transformation of these waterfront community markets varies significantly.

This research, therefore, aims to analyze the urban morphological transformation of riverfront communities in the agricultural areas of the Nakhon Chaisri Basin from the past to the present in order to gain an insight into its future prospects and to provide suggestions on the spatial planning of these communities to preserve their valuable identities.

Methodology

Theories

Spatial configuration analysis was used to explain the urban morphological transformation of riverfront communities in the agricultural areas of the Nakhon Chaisri river basin. The analysis was based on the theory of natural movement, the theory of movement economy process and the theory of spatial centrality. According to the analysis, a community and a city, in general, comprise two fundamental spatial elements – passageways and public space – that facilitate a way of life and activities (Hillier and Hanson, 1984). Very well connected passageways help both inhabitants and visitors with different commuting purposes to move to and through their destinations more easily. An area that lends itself to a density of movement and various degrees of activity is usually well integrated into the urban network resulting from natural movement (Hillier et al. 1993) that allows commuters to reach their destinations different degrees of use due to the types of network connections. Different networks lead to different potentials of accessibility and this discrepancy reflects the frequent use of that area. As a result, one area is more quiet than another and the density of passageways influences the number of activities performed along each passageway. This is in line with the movement economy process (Hillier 1996) in that an activity that does not depend on a large number of trips made by a person, such as living or agriculture, is seen along a passageway with a low potential of accessibility, while for an activity that depends on a large number of trips such as trading clusters along a

passageway with a high potential of accessibility traders can take advantage of the trips and this area can attract other trading activities. High natural movement depends on the potential of the network connection and the number of activities that attract other activities. Multiplier effects result from these attractors; therefore, more and more trading activities are seen in this area forming a waterfront market and later becoming a crowded urban community along with other nearby areas with fewer activities. Hillier (2000) considers this crowded urban community a live center since it has dynamic centrality. This urban morphology gives rise to a riverfront community, and different morphologies lead to different urban morphology transformations.

It can be concluded that the urban morphological transformation of riverfront communities in the agricultural areas of the Nakhon Chaisri river basin can be explained by utilizing the three theories mentioned above. Space syntax was used to analyze their spatial configurations by creating spatial model maps to investigate the relationship between passageway networks and public space and the potential of accessibility to the areas and to study the spatial centrality of urban communities. A system to measure the distance of each route and a system to determine the relationship between one route and another were set up to explain how the passage networks affect the development of spatial configurations at different times.

Research methods

The methodology involved a tool used to analyze the spatial configurations and analyses of activities that reflect land use patterns. It can be described in detail as follows:

The analysis of spatial configuration characteristics and spatial centrality determines the potential of accessibility to space and urban routes that facilitates free flow of people. According to urban morphology (Hillier and Hanson 1984), the connection of passageways is related to the popularity of a passageway used within the city. People tend to use the most direct and shortest route; therefore, an axial line is drawn to connect convex spaces that people can walk to in a real situation. The axial line is the longest straight line and has the fewest number, representing natural movement. All of the axial lines are linked in a network called the axial map or spatial model map of an urban community. The data for the spatial model were based on the rivers, canals, roads, rails and trails that were in use at different periods. The sources of information were divided into three: an old map from 1912 to 1917, a geographical map L7018 from 1968 to 1975, and the Royal Thai Survey Department's map (1: 50,000) from 1998 to 2001.

Space syntax was used to process the information of the spatial model map to prioritize the relationship between space accessibility in the entire network (Tuner, 2003). The popularity of accessibility was displayed in a spectrum of color from red to blue. The highest potential for accessibility or integration was found in the urban fabric

as shown in red (the most concentrated) to orange, yellow, green and blue (the least concentrated). The quantitative statistics for each route were also included. An ideal spatial model map of a city should comprise all spectrums of color (red to blue) because it represents multi-layers of the potential for accessibility of the route network in that city. The spatial centrality or a riverfront community should comprise warm spectrums of color, implying a cluster of settlement with a high potential for accessibility and a potential for being a live center (Hillier, 2000). The outer areas should comprise cold spectrums of color, implying a low potential for accessibility or an agricultural area.

Then the spatial model map was analyzed in conjunction with land use patterns. These patterns were secondary data taken from geographical maps, statistical information and related documents as well as field surveys representing land use patterns such as agricultural areas, commercial areas and areas of other activities as well as routes and public space. In addition, the data included in-depth interviews of key local informants in the market and agricultural areas. They provided information about land use patterns, area development and changes in those areas. Data triangulation (Denzin 1978) was used to validate the data collected from February to July 2014 to obtain information about the latest changes.

Urban Morphological Transformation of Riverfront Communities

The spatial model map revealed three districts in Nakhon Pathom Province through which the Nakhon Chaisri River

flows. The three districts - Bang Len, Nakhon Chaisri and Sam Pran -cover an area of 1,122 square kilometers. It was found that the development of the basin could be divided into three major phases: 1) plantation-rice field-orchard areas encompassing riverfront communities (1858–1957), 2) urban communities taking over plantation-rice field-orchard areas (1958–1992) and 3) urban sprawl (1993–present).

Period 1: Plantation-rice field-orchard areas encompassing riverfront communities (1858–1957)

The characteristics of these riverfront communities were more pronounced because after 1857, more than 200 canals were dug to provide water for a wider span of agricultural areas along the river; therefore, those areas encompassed the communities. The canals were used for commuting and transporting produce. With the introduction of the canals, more communities were seen along the river and the canals. In 1894, during the reign of King Rama V, a new municipality, the administrative system, was introduced, resulting in the integration of Nakhon Chaisri, Supanburi and Samut Sakhon. It was named Nakhon Chaisri Municipality and the administrative center was in Nakhon Chaisri; as a result, this municipality rapidly became an urban community. However, it was located on a narrow strip of land so it was difficult to expand. King Rama V, therefore, had the center relocated to Pra Pathom Chedi Sub-district in 1901. King Rama VI had Muang Nakhon Chaisri renamed Muang Nakhon Pathom, and Pra Pathom Chedi was named Nakhon Chaisri

District. The Chedi Bucha Canal connected these two places (Pornsiripongse et al., 2008: 113, Jindamaneerrojana, 2011: 25). A railroad track (Bangkok Noi (Thonburi) – Petchaburi) built in 1903 ran past Nakhon Chaisri Municipality.

From 1910 to 1925, Muang Nakhon Chaisri was the route that King Rama VI took to go to Muang Nakhon Pathom to perform his royal duties; therefore, Muang Nakhon Chaisri and Nakhon Pathom became more important. Houses were located along the Nakhon Chaisri River and areas further inland. In 1933, the wooded areas along the river were transformed into agricultural areas that could fetch high prices. In 1942, a boat taxi service came into existence and carried both passengers and goods from Supanburi Province along the Thachin River, passing Nakhon Pathom to Samut Sakhon Province. The company was located at Ngio Rai Pier where people would stop to take a train (to Bangkok) at Ngio Rai Train Station (Pornsiripongse et al. 2008). This created a junction where a land route and a water route met and a riverfront market was established. From Supanburi to Nakhon Pathom, such markets were found at Bang Luang, Sam Kha, Bang Sai Pa, Khun Pra Thawee, Bang Len, Bang Phasi, Mai Bang Pla, Bang Nok Krathung, Lam Praya, Huay Plu, Tha Na, Rang Krathum, Ngio Rai, Don Wai, and Sam Pran, as shown on the 1913 map (The Royal Thai Survey Department). These waterfront markets reflected the fact that the city originated from a waterfront market with railroad tracks, rivers, canals and wagon trails facilitating the transportation of people and goods in and out of vicinal areas and Bangkok (Figure 7).

Urban Morphological Transformation of Riverfront Communities in The Nakhon Chaisri Basin, Thailand

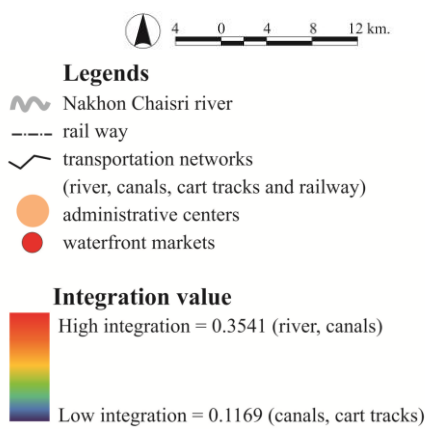
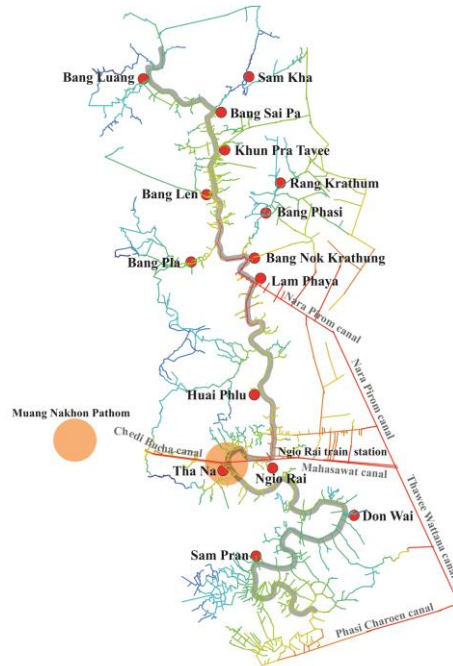
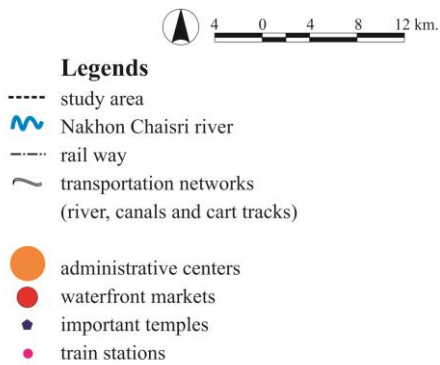


Figure 7 The Locations of Waterfront Markets, Crowded Communities and Agricultural Areas in the First Phase

Figure 8 Spatial Configuration during the Period of Plantation-rice field-orchard Areas Encompassing Riverfront Communities (1858 – 1957)

The spatial configuration of this period (Figure 8) revealed a non-systematic water transport network caused by the meandering Nakhon Chaisri River and canals as well as winding wagon trails due to the topography. Long straight lines representing dug canals and railroad tracks also appeared, and the highest degree of natural movement and that of the potential for accessibility to the spatial centrality were found in the center of the river in Nakhon Chaisri District because its grid was almost perpendicular across the center and its high integration value was at 0.3541. A solid red line was seen over the point where Narapirom Canal and Thawiwattana Cannal met the Nakhon Chaisri River down to Mahasawat Canal and Chedi Bucha Canal. The waterfront markets and crowded communities were clustered on the banks of the Nakhon Chaisri River, which branched out into three markets (Huay Plu, Tha Na and Ngio Rai). The canals were related to rice-growing areas running from the upper part of the river. Later there was a mix of paddy fields and coconut and bamboo trees further down the river where farmers drew water for their farms. The low degree of natural movement and that of the potential for accessibility were found in the lower basin of Sam Pran District. The low integration value was at 0.1169. A light-dark blue line represented a wooded area where there was no community or waterfront market. However, the markets and communities in this area were located in areas whose degree of potential for visibility and accessibility was average to low. This might be because of the continuation of the water route network and other open areas such as branches of canals and wagon trails. However, these markets and communities were on the route of the boat taxi; as a result,

they could become crowded markets and communities.

According to the data, it is clear that the spatial configuration during the first phase resulted from different geographical conditions and ecological systems, leading to different types of establishment and types of agricultural practices such as growing rice, fruit trees and other plants. During this phase, the agricultural areas outnumbered the residential and commercial areas so it can be said that plantations, fields and orchards surrounded the riverfront communities, most of which were situated at the mouths of canals and at the points where wagon trails and canals met. The river mouths and junctions were important factors that promoted the growth and the density of waterfront markets and communities. The higher potential for visibility and accessibility, the more advantageous for a place. Take Nakhon Chaisri District as an example. However, a very well-connected route network that is widely used alone can also create such a market and community, for example, in Bang Len District and Sam Pran District.

Period 2: Urban communities taking over plantation-rice field-orchard areas (1958 – 1992)

In 1957, Thailand entered a period of national development following the guidelines set by the 1st National Economic and Social Development Plan (1961–1966). The plan focused on the development of infrastructure and public utilities, resulting in the spatial configuration of the Nakhon Chaisri river basin since the construction of roads and bridges, particularly the

*Urban Morphological Transformation of Riverfront Communities
in The Nakhon Chaisri Basin, Thailand*

construction of Petchakasem Road in 1962, in the rural areas and agricultural areas of Nakhon Pathom Province; therefore, a trip from Bangkok to this province became quicker than traveling by train or boat. At first, however, people still traveled by boat or train until a bus service was opened and it became more popular. Eventually, the boat taxi was terminated services in 1967. In 1980, more roads were built along the wagon trails and in 1984 Pechakasem Road was connected with the 6-lane Borommaratchachonnani Road. This new road was connected with Phutthamonthon Road 4, 5, 6 and 7. In 1988, a bridge crossing the Nakhon Chaisri River was built to connect nearby provinces – Supanburi, Pathum Thani and Nonthaburi – so people could travel further and could choose to travel by boat, train or bus.

Rice growing was done in most of the areas in Bang Len since it was a large plot of land and was divided into smaller plots by canals that paralleled roads. However, the number of these roads was fewer than those in Nakhon Chaisri District and Sam Pran District. Rice growing, farming and fruit tree growing were scattered in Nakhon Chaisri District with a water network and roads running through the fields, farms and orchards. Orchards predominated in Sam Pran District; as a result, the most ditches were found here and roads were more winding than in the other two areas because of the topography. At that time, the urban communities in these three districts were not so crowded but Muang Nakhon Pathom bordering Nakhon Chaisri District to the west, Thonburi to the east and Sam Pran District expanded further, especially along Petchakasem Road and

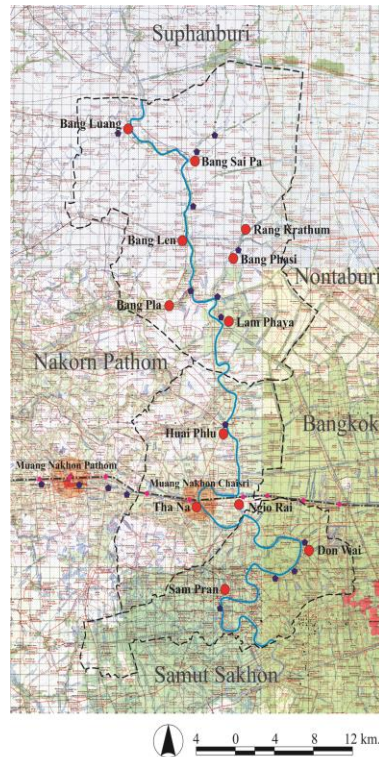
Borommaratchachonnani Road. The construction of roads and bridges facilitated land transportation; therefore, more and more people settled along the roads so they were less dependent on rivers and canals for water consumption and transportation. In addition, factories were built along the rivers. These factories discharged waste water into the rivers and canals. However, farmers still needed water from the rivers and canals for their fields, farms and orchards but their decreased dependence on the rivers and canals had a direct effect on the existence of waterfront markets and communities because water transportation was less popular. Due to this, since 1987, waterfront have markets lost their importance and been replaced by shophouses built along the roads (Figure 9).

The spatial configuration at this time (Figure 10) was shaped by water and land route networks; as a result, it was a combination of two lines with similar proportions, in that, (1) the natural movement of canals and roads followed the topography and (2) the long straight lines of railways, dug canals, and newly-constructed roads affected the trends of natural movement and potential for access to the spatial centrality. The concentration of natural movement and potential access to the spatial centrality were at the lower part of the basin bordering Nakhon Chaisri District and Sam Pran District since the old water route network co-existed with the new road network more densely than in other areas, especially in the areas Petchakasem Road ran through. In addition, in this area, there were small canals and small roads crisscrossing in the orchard areas, resulting in a high integration value at 0.6268. The dug canals included

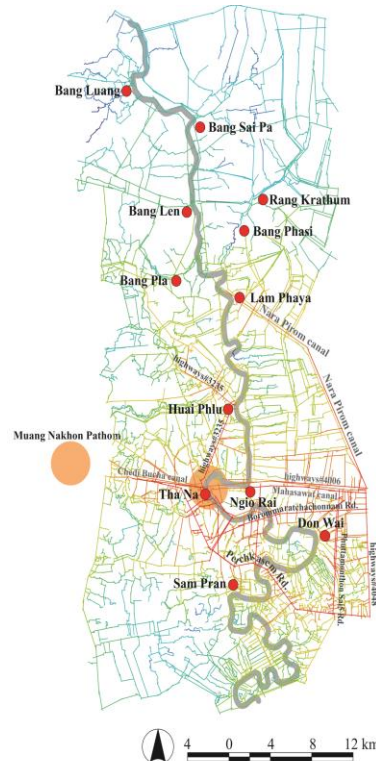
Naraphirom Canal, Mahasawad Canal, Yong Canal and Chedi Bucha Canal. The access potential to the spatial centrality through these canals was twice as high as that in the past while the potential for access to the spatial centrality through main roads was about the same at 0.6742. These main roads included Petchakasem Road, Borommaratchachonnani Road, Phuttamonthon 5 and railroads as shown by the red line. People chose to travel on land more than on water and this corresponded to the crowded communities in Nakhon Pathom District, which expanded towards Nakhon Chaisri District. The lowest degree of natural movement and potential for access to the spatial centrality was at the upper part of the basin in Bang Len District, whose integration was as low as 0.1620 at Bang Pasi Canal and 0.1954 in dead-end community roads as shown by the light blue and dark blue lines that loosely crisscrossed. An explanation for this is that there was not a main road running along these areas and the spatial configurations of water courses were transformed; as a result, some canals disappeared as they were filled in to make way for roads.

It is clear that the spatial configuration in this period showed a transition from water transport to land transport, leading to a lower degree of natural movement and potential for access to the spatial centrality by water and the witnessing of urban expansion along the roads. This also resulted in the decreased popularity of waterfront markets that were later difficult to access. However, agricultural areas could be more readily accessed due to new road networks. Thus, this period can be referred to as one in which “urban communities took over plantation-rice field-orchard areas.” The old and new networks – both water and road – increased the general visibility potential and the potential for access to the spatial centrality of the areas, particularly, those in Nakhon Chaisri District and Sam Pran District, leading to further urban expansion and more crowded communities than in other areas in Bang Len District whose visibility potential and the potential for access to spatial centrality was lower but its existing transport networks were still intact and in use so most of these areas were for agriculture.

Urban Morphological Transformation of Riverfront Communities in The Nakhon Chaisri Basin, Thailand



- Legends**
- study area
 - Nakhon Chaisri river, canals
 - rail way
 - road
 - administrative centers
 - waterfront markets
 - important temples
 - train stations
 - urban communities
 - agricultural areas
 - rice fields



- Legends**
- Nakhon Chaisri river
 - rail way
 - transportation networks (road, river, canals, cart tracks and railway)
 - administrative centers
 - waterfront markets
- Integration value**
- High integration = 0.6268 (river, canals) = 0.6742 (roads)
 - Low integration = 0.1169 (canals) = 0.1954 (roads, cart tracks)

Figure 9: Waterfront Community Markets: Crowded Communities and Characteristics of Agricultural Practices of the Second Phase

Figure 10: Spatial Configuration during the Period of Urban Communities Taking Over Plantation-rice field-orchard Areas (1958–1992)

Period 3: Urban sprawl (1993-present)

These areas underwent subtle changes, but after 1992 these changes became more noticeable when the riverfront communities were transformed into urban communities with the introduction of main and minor roads passing the agricultural areas and along the rivers and canals. As a result, land transport has become more popular so houses and shops are seen along the roads. Real estate housing projects, commercial buildings and factories have sprung up. During the past 20 years (1993–2013), the number of structures has increased threefold in these three districts. The highest number was in Sam Pran District, followed by Nakhon Chaisri District and Bang Len District (Department of Provincial Administration 2014). At the same time, the agricultural areas have been reduced in these three districts, particularly in Nakhon Chaisri District and Sam Pran District (National Statistical Office 2014). The agricultural practices in the three districts are different in that in Bang Len District almost all of the areas are rice fields. A large piece of land is dissected by a canal network and roads running along the canals. but the road and canal networks are not tightly woven. In Nakhon Chaisri District, farmers grow rice, fruit trees, flowers, vegetables and herbs. The canal and road networks are tightly woven while in Sam Pran District, farmers grow mostly fruit trees, flowers and herbs. Farmers still practice ridging; therefore, a large number of Ditches, small canals, and winding roads are found in this district (Nakhonpathom Cultural Office, 2014). The areas around the waterfront markets that can be accessed by road have become crowded urban

communities and new commercial areas; however, trading is still carried out only within the waterfront markets. Also, some of these markets have been transformed into tourist attractions or residences but some have been completely transformed and nobody can recognize that they were once waterfront markets. The urban communities in Nakhon Chaisri river basin originated from riverfront communities. According to the 2000 maps, urban expansion in the Nakhon Chaisri District was influenced by the urban expansion of Nakhon Pathom District but that of Sam Pran was influenced by the urban expansion of Samut Sakon Province and Bangkok along Petchakasem Road and Borommaratchachonnani Road. One can take Highway 346 from Bang Len District to Supanburi Province and Pathum Thani Province. All of these factors resulted in three markets in three districts – Bang Len market, Tha Na market (Nakhon Chaisri) and Sam Pran market – becoming more crowded than other areas. This explains why Sam Pran market became Muang municipality, which is a higher level, while Bang Len and Tha Na became Tambon municipalities. In addition, the markets at Bang Luang, Rang Kratum, Lam Paya, Huay Plu and Don Wai became Tambon municipalities (Department of Provincial Administration 2014) as shown in Figure 11.

Urban Morphological Transformation of Riverfront Communities in The Nakhon Chaisri Basin, Thailand

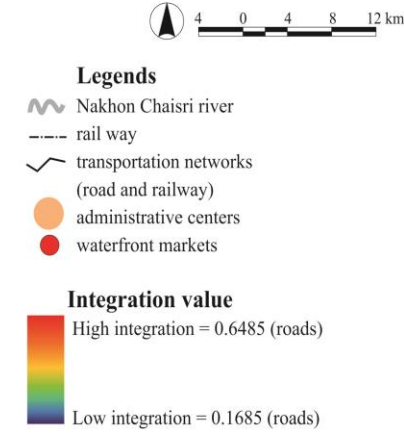
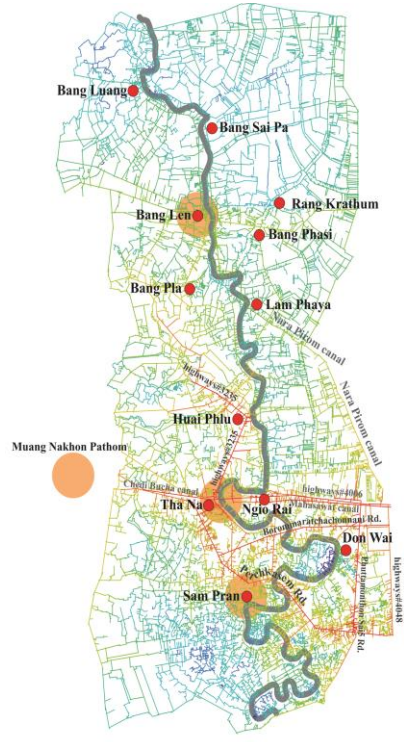
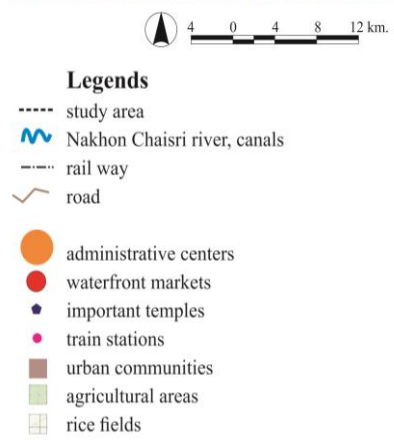
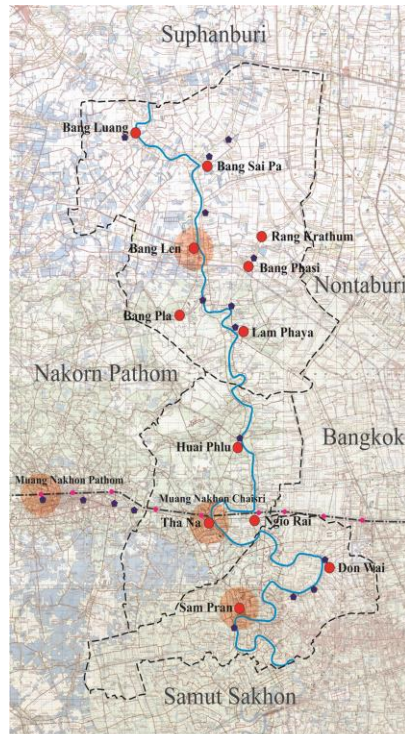


Figure 11: Waterfront Community Markets: Crowded Communities and Characteristics of Agricultural Practices of the Second Phase

Figure 12: Spatial Configuration during the Period of Urban Sprawl (1993–present)

The spatial configuration during this period (Figure 12) was formed by the land route network comprising two distinct lines, in that, (1) many of the natural movement lines running towards villages wind along the areas. These are short lines running closely to one another throughout the basin especially in the lower part. (2) The rather long straight lines showing main roads, roads along dug canals and railroads are woven into a perpendicular grid and found in the middle and lower part of the basin, resulting in a high degree of natural movement and the potential for access to the spatial centrality in Nakhon Chaisri District and the areas that border Sam Pran District. A high integration value (0.6485) was on Petchakasem Road and such main roads as Borommaratchachonnani Road, Phutthamonthon 5 and railroads shown with the red lines. This is in line with the expansion of crowded communities in Tha Na market in Nakhon Chaisri and in Sam Pran market. The low degree of natural movement and potential for access to spatial centrality is found on the upper and lower parts of the basin but the lowest degree is found in the lower part of the basin whose integration value is at 0.1685. These areas are agricultural areas situated across from Don Wai market. Low integration is caused by the fact that most of the roads end at the banks of the Nakhon Chaisri River as shown by the light blue and dark blue lines clustering and segregating out from the urban areas. In addition, the degree of natural movement and potential for access are also low in the upper part of the basin as shown by light blue and dark blue lines loosely interwoven.

It can be concluded that the present spatial configuration is completely changed when compared with that in the past due to the land transport network that replaced the water transport network. This has led to a high degree of natural movement or the potential for access to spatial centrality. Currently, the land transport network covers the whole river basin including agricultural areas, resulting in greater construction work and urban expansion and that is why this period is referred to as “urban sprawl.” The high degree of visibility potential and potential for access is found in crowded urban communities, and there is a high risk of losing agricultural areas. Tha Na market in Nakhon Chaisri District is a classic example of this. However, crowded urban communities can also be found where the visibility potential and potential for access are low, such as Sam Pran market in Sam Pran District where minor roads are interwoven rather tightly and there is a lot of construction work as well as some main roads running past. Similarly, in Bang Len market in Bang Len District, houses and shops cluster along the main roads, and the passageways within the communities are still in good condition so this can bring about crowded urban communities.

Conclusions and Recommendations

According to the findings, the urban morphological transformation of riverfront communities in the agricultural areas of the Nakhon Chaisri River can be divided into three phases. The first phase (1858–1957) was one of plantation-rice field-orchard areas encompassing riverfront communities. The degree of visibility potential and potential for access to water transport

*Urban Morphological Transformation of Riverfront Communities
in The Nakhon Chaisri Basin, Thailand*

networks and open space was the highest corresponding to the settlement clustering along the rivers or canals more than in other areas, leading to the development of waterfront markets. The network was connected naturally so changes were slight and took more time than during the later phases. During the second phase (1958–1992), the construction of roads combined transport by land and by water and doubled the visibility potential and potential for access to water transport networks and open space. This degree was about the same as that of the land transport network, but the water transport potential was still lower in line with the fact that land transport was easier and faster; as a result, more and more shops and houses were seen along the roads. Agricultural areas were also more readily accessible in contrast to waterfront markets, transforming the markets into unfrequented ones. This phase was one of urban communities taking over plantation-rice field-orchard areas. Changes continued and after 1992, the basin entered phase 3 (1993–2013), when riverfront communities underwent urbanization because the land transport network completely replaced the water transport network, leading to the highest degree of visibility potential and potential for access to the land transport network. Houses and shops were packed along the roads and moved towards the agricultural areas. This phase was one of “urban sprawl.”

The findings confirm the theory of spatial centrality development (Hillier 2000) in that the efficient connection of the passageway network – either land transport or water transport – with open space affects the degree of natural movement to an area. A

high degree of accessibility leads to a high degree of natural movement and a cluster of activities, especially trading and settlement; on the other hand, a low degree of accessibility leads to a low degree of natural movement and sluggish activities such as agriculture. However, social and cultural aspects also play a role in the choice of traveling. A transport network in that area may have low accessibility, but it is the network that the residents are used to, so this network can be of high circulation in line with the social logics of space and spatial logics of society (Hillier and Hanson 1984). Likewise, some waterfront community markets are not located in areas with high accessibility, but their settlement is caused by social and other factors such as being on the routes of boat services or where goods are loaded and unloaded. Later these waterfront community markets became urban communities, some of which expanded towards nearby communities.

The findings also indicate that a change from traveling by boat to that by car in the Nakhon Chaisri river basin resulted in a higher degree of accessibility; in other words, traveling within the area became easier and faster because of the expansion of the land transport network, while, however, brought about a reduction in agricultural areas. In Nakhon Chaisri District and Sam Pran District, the land route network had the highest degree of accessibility and waterfront community markets were neglected along the roads. As more people lived along the roads, there were fewer people in the markets. Agricultural areas have been used for other purposes and some parts of the water transport network have been filled in or become impassable. In

Bang Len District, agricultural areas are still intact even though the city is expanding mainly because not many main roads run through this district. It is suggested that the ecological system and spatial configuration should be taken into consideration because agricultural areas do not require high accessibility; therefore, the construction of main roads is not necessary. The water transport network should also be restored and reconnected to the land transport network to reduce the number of new roads constructed. More road construction means fewer agricultural areas and reconnection will lessen the density of land traffic in waterfront communities and in agricultural areas whose ecological systems are highly fragile. As for city planning, land use should be strictly controlled to ensure the preservation of the unique riverfront communities in the river basins in the Central Plains, which will, in turn, enhance the local economy, and improve the ecological system.

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