Transformation of the Canal-Side Settlements in Greater Bangkok
การเปลี่ยนแปลงการตั้งถิ่นฐานชุมชนริมน้ำในกรุงเทพมหานคร

Chaweewan Denpaiboon, Dr.[1] and Professor Mamoru Tohiguchi, Dr.[2]
ดร. ฉวีวรรณ เด่นไพบูลย์ และศาสตราจารย์ ดร. มะโมะรุ โตะฮิกุจิ
[1]Faculty of Architecture, Thammasat University
[2]Faculty of Environmental Engineering Information,
Tottori University of Environment Studies

Abstract

This paper presents a case study of canal-side settlements [1] in greater Bangkok, which focused on canal-side settlements transformed by modernization over a period of time. Three different sets of data, from every twenty years in the years 1952, 1974 and 1998 compiled through the aerial photographic interpretation technique were examined, and a survey research and field survey were undertaken, which were based on the investigation of different houses and different locations of settlements that have affected the inhabitant's altitude towards environmental concerns. The paper examined two levels in the study for the purpose of (1) the analysis of settlement structure (fabric pattern of settlement) (2) the analysis of change in building types from old types to new types. The findings found that changes in building construction types, which occurred as dwelling, were built in modern style and materials. First, the settlement structure has varied by sites which are related to factors such as space, canals, roads, land sub-divisions, and site patterns in different locations in greater Bangkok. Second, changes in building construction type occurred and dwellings were built in modern styles and materials. Moreover, those changes of building types are correlated with the change in settlement structures in the same way. The transformation process of house forms indicated the change from a traditional to a modern type, which took over forty years in Bangkhu Wiang (urban-fringe), Klong 9-10 and Sai Gong Din (suburb area). Meanwhile the process took twenty years in Mahasawat (urban) since it was the nearest to the CBD.

บทคัดย่อ

การศึกษานี้ ได้ทำการวิเคราะห์และสังเคราะห์กระบวนการเปลี่ยนแปลงที่เกิดจากความทันสมัย จากการพัฒนาถนนที่มีต่อชุมชนริมน้ำกรุงเทพมหานคร ในช่วงเวลา 40 ปี โดยใช้เทคนิคการแปลภาพถ่ายทางอากาศของ 3 ช่วงเวลา คือ ปี 2495 ปี 2517 และปี 2541 และการสำรวจข้อมูลจากภาคสนามด้วยแบบสอบถาม การศึกษานี้ ได้ตรวจสอบข้อมูลใน 2 ระดับ ตามเป้าหมายของการศึกษา คือ 1) การวิเคราะห์การเปลี่ยนแปลงโครงสร้างของชุมชนริมน้ำ และ 2) การวิเคราะห์กระบวนการเปลี่ยนแปลงของรูปแบบที่อยู่อาศัย ข้อค้นพบจากการศึกษาพบว่า โครงสร้างกายภาพของชุมชนริมน้ำได้เปลี่ยนไป

ทั้ง 4 ชุมชน ที่แตกต่างกัน โดยขึ้นอยู่กับแกนโครงสร้างของชุมชนอื่น ได้แก่ เส้นทางน้ำ เส้นทางถนน ชุมชน (บางคูเวียง) ที่ยังใช้เส้นทางน้ำเป็นปัจจัยหลัก การเปลี่ยนแปลงทางโครงสร้างของชุมชนและรูปแบบที่อยู่อาศัยอย่างค่อยเป็นค่อยไป สำหรับชุมชนที่ใช้เส้นทางถนนเป็นเส้นทางหลัก การเปลี่ยนของชุมชนได้เกิดขึ้นอย่างรวดเร็วและรูปแบบของที่อยู่อาศัยจากบ้านแบบดั้งเดิมเป็นบ้านสมัยใหม่ ไปพร้อมกับเส้นทางถนน โดยเฉพาะ ชุมชนที่ตั้งอยู่ในเมืองใกล้ CBD การเปลี่ยนแปลงชุมชนและรูปแบบที่อยู่อาศัยเกิดขึ้นอย่างรวดเร็วภายในช่วงเวลา 20 ปี แต่สำหรับชุมชนที่ตั้งอยู่ในเขตชานเมือง การเปลี่ยนแปลงโครงสร้างของชุมชน และรูปแบบที่อยู่อาศัยอย่างค่อยเป็นค่อยไป และใช้เวลาเกือบ 40 ปี ได้แก่ ชุมชนทรายกองดิน และชุมชนคลอง 9-10

Keywords:

Transformation (การเปลี่ยนแปลง)

Modernization (ความทันสมัย)

Canal-Side Settlements (ชุมชนริมน้ำ)

Aerial Photographic Interpretation Technique (เทคนิคการเปลี่ยนแปลงภาพถ่ายทางอากาศ)

Greater Bangkok (กรุงเทพมหานคร)

1. INTRODUCTION

In Bangkok, the canal house was probably the first of all man-made buildings, buildings on land, on the other hand, must have followed later [2]. The canal-side settlements [3] system evolved in places where people lived, worked, and played and it represented much of the "built environment" [4], the frequent phenomenon was of an old physical form. We found that the old settlement fabric pattern was transformed by displacement; however, the old is not necessarily replaced by new. The acceptance of a new mode does not necessarily lead to the disappearance of the older form. New forms may only increase the range of alternatives [5].

The phenomenon of canal-side settlements was a result of land development, which happened over a period of time with the occurrence of modernization. Because of the transformation of the Thai economy, agricultural products and other export products were increasingly exported to the world markets in the nineteenth century [6]. The land area was increasingly extended for agricultural usage by land extensions and canal construction. Records indicated that in the early period (1760s-1850s) land was developed in the forms of short cut canals, moats and canal networks. Next, after the Bowring Treaty was signed in 1855, excavation of canals was increased to more than 22 canals to facilitate selling products abroad and also to expand rice farm land. Land development peaked in 1888 since canals were developed into a system for irrigation serving rice farming [7]. The large numbers of canals, both man made and natural, were used as thoroughfares for many years. However, 80 years after Bangkok was, as a capital, beginning to lose its relative prominence, much of the urban space transformation occurred throughout Bangkok, especially on the east side of urban areas (Figure 1) during the period of rapid urbanization. Hence, this study focused on the existing cases in urban-fringe areas and the outskirts of Bangkok, which have the appearance of traditional canal-side settlements.

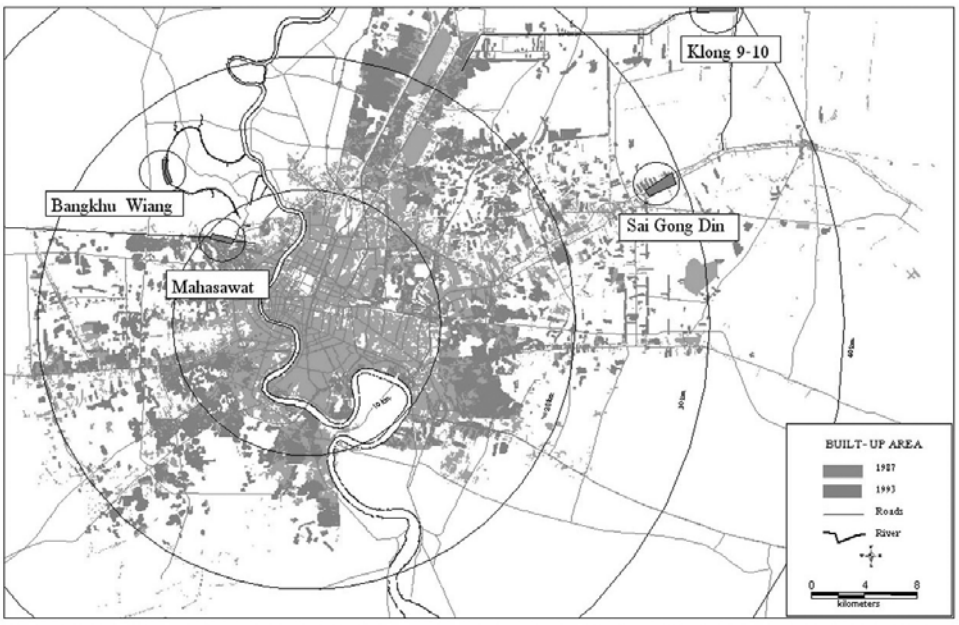

Figure 1 Location of the case study areas and BMR built-up area

2. OBJECTIVES OF THE STUDY

The aim of this study is to analyze the transformation process of canal-side settlements in greater Bangkok by modernization, and to discover how they have been transformed by investigating through a ground survey and using the aerial photographic interpretation technique. We also analyzed the settlement pattern and transformation process in order to discover the relationship between building type and settlement structure. Finally, the study attempted to verify the hypothesis; transformation by modernization following road development will bring about rapid changes in canal-side settlements.

3. METHODOLOGY

The study approach employed a survey research, a ground survey and interviews. It also employed the aerial photographic interpretation technique in the three periods and a geographic information system. Computer data analysis for this study included content analysis and comparative analysis "what was transformed, why, and how". The study also analyzed primary data that identify settlements and house type changes. This was a purpose of the study to observe the transformation process of the traditional patterns of canal dwellings. The following physical data were collected from the analysis of the aerial photographic land use survey: 1) roads, sub roads and walkways, 2) waterways, rivers and canals, 3) buildings, residential houses, factories, and temples, 4) open space or land for under clearance or vacant, 5) agricultural area i.e. gardens, farms, paddy fields. This was done according to existing data sources, from an aerial photography surveyed in 1952 on scale of 1:30,000 which was enlarged into a scale of 1:20,000 to provide detailed picture which enabled an analysis of both details and the overall picture. This method was used in the 4 study areas. An aerial photography of survey in 1973 on a scale of 1:15,000 was enlarged into a scale of 1:10,000 for 3 study areas. Klong 9-10 did not have an aerial photographic survey in 1973. Also an aerial photographic survey in 1995 on scale of 1:6,000 was used to provide more detailed data.

Information Sought	Reserch Technique
• Bangkok aquatic city; history and background, and housing settlements patterns • Housing and architectural forms • Transformation of the canal-side settlements in the 4 study areas • Typology of the canal-side settlements and indicators of transformation • Mechanism of transformation by modernization	• Secondary data from historical an tecedents chronological research literature reviews and interviews with elderly house owners • Usual sequence in the ehronological development of events • Aerial photographic interpretation technique in three periods • Field survey, and GIS by computer • Survey research by questionnaire • Photographs and sketches and drawings • Interviews with house owners

Figure 2 Information sought and research technique employed

4. REVIEW OF LITERATURE

Research concerning the transformation of canal-side settlements has continuously been undertaken. However, many points have been unclear concerning the impacts of modernization by road development on canal-side settlements, in terms of the types of change in the form of the canal-side settlements and the patterns or the changes related to urban structure. How and why did this change occur? The significance of transformation has rarely been researched. There is only one scholarly work by Habraken who was concerned with form of transformation [8] and used an analytical approach. Many studies have focused on different aspects of canal-side settlements; such as canal house spacing [9], transformation of aquatic habitation to land habitation, and the transformation of raft house forms to canal house forms [10]. Another study focused on the conservation of canal housing and the environmental surroundings in Bangkok Noi canal [11]. Those studies were different in many dimensions from this study, which aimed totally to analyze the transformation of canal side settlements and had the following features; 4 areas comparison study, 2 levels of analysis (transformation of settlement structure and building type) based on macro and micro analysis by using the aerial photographic interpretation technique in concurrence with the investigation.

5. CHARACTERISTICS OF THE FOUR SITE AREAS

According to site selection, four different sites, locating 9, 15, 30, and 39 km. from CBD, were examined. They possess the images of old settlements as well as the signs of transformation into urbanized development.(Figure 2)

The first site is on the Mahasawat Canal [12], in the lower part of the Chao Phraya River where urbanization has taken place. It is called Mahasawat community in Taling Chan district. The study area is about 558,500 sq.m.

The second site is Bangkhu Wiang, which is situated at an urban-fringe area on the Mae Nam Om Noi (Om Noi River) [13] with 1,254,000 sq.m of total study area. This is an urban fruit growing area where various types of fruit are grown in polders. The ground is prepared into a web of dykes and ditches.

The third site is located in a suburban area in the eastern part of Bangkok, which is primarily an area of paddy fields, vegetable gardens and fish-ponds. The site is called Sai Gong Din community, which is on the Sean Saep Canal [14] and comprises 1,008,000 sq.m.

The last site is also located in a suburban area in the North Eastern part of Bangkok on Hok Wa Canal [15] which is a paddy field area where development has taken place very slowly. This site is called Kasettakorn Klong (canal) 9-10, consisting of 1,428,000 sq.m of total study area. (Table 1, Figure 3)

6. FORMS OF CHANGE IN SETTLEMENTS STRUCTURE

The results of the aerial photography interpretation technique have shown the form of changes in different areas of urbanization (Table 2) as follows:

An illustration of land use dynamics in Mahasawat, was over the forty years period from 1952 to 1998, the agricultural area decreased by 49.1 per cent from 78.7 per cent in 1952 to 29.6 per cent in 1998 with massive increases in the allocation of land to land under clearance or vacant land (39.6 per cent). The residential area expanded to 13.3 per cent at a

Table 1 Characterristics of the four case study areas

Parameter	Mahasawat	Bangkhu Wiang	Sai Gong Din	Klong 9-10
Building type	1-2 Storey Single Houses	1-2 Storey Single Houses	1-2 Storey Single Houses	1-2 Storey Single Houses
House style	Vernacular Houses Traditional Thai House Modern House	VernacularHouses Traditional ThaiHouses Modern House	Vernacular Houses Modern Houses	Vernacular Houses Modern Houses
Economic Activity	Informal Sector Retail Traders Food Shops	Gardens, Farms, Boat Shops Shop house	Shop house/ Hawker Retail Traders	Paddy fields , farms Shop house
House Ownership	Self-owned	Self-owned	Tenant Self-owned	Tenant
Land Ownership	Self-owned	Self-owned	Tenant Self-owned	Tenant
Existing Land Use	Residential Predominately	AgriculturalPredominately	ResidentialPredominately	Agricultural predominately
Existing Building Use	Mixed Residential and commercial area	Agricultural Predominately	Residential area	Mixed Residential and Agricultural area
Household Size*	5	4.9	4.5	4.9
No. of Population*	230	224	230	238
Distance from CBD* (km.)	9	15	30	39
Time-Distance* (by car)I5	30	60	60	90
Plot size per house* (sq.m.^{2})	385.1	372.0	431.6	501.3

Source: Survey by authors in 1998

Note: 1. Vernacular house was a simple house style, which was created and design by owner.
2. Traditional Thai House style (Ruan Thai) was both located on land and in water.
3. Modern house style will be built on land or encroach a little upon the canal and design of house will be different according to the owner's taste and requirement
* Source of data by survey such as household size, no. of population , distance, plot size per house

Figure 3 Canal-Side Settlements

fast rate. Land for commerce (1.2 percent), industry (0.3 percent), and roads (1.2 percent) also showed an increase. All these developments have been possible, in part, through a reduction in the proportion of land covered by gardens and canals as the natural areas have been changed over the years. Obviously complementary structural change in the shape of the settlement pattern has been unplanned.

Considering the land use dynamics in an urban-fringe area, it was found that Bangkhu Wiang, where is located on the West side, was just as the natural areas have been changed over the years, other forms of nature have been "controlled" into agricultural zones mostly landscaped with fruit trees and vegetable plots. The pattern of land use has changed over the time of the forty years period from 1952 to 1998. The agricultural use has decreased by 25.9 percent from 71.1 percent in 1952 to 45.1 percent in 1998. Changes were increases in the allocation of land to land under clearance or vacant land (17.5 percent), residential use (5.0 percent), religious use (1.7 percent), educational use (0.8 percent), and roads (0.6 percent).

Table 2 is an illustration of land use dynamics in a suburban area on the East side (Sai Gong Din) with agricultural areas (paddy fields). The analysis of land use from analyzing and interpreting the data revealed that over the forty years period, from 1952 to 1998, land use for agriculture declined rapidly. Land use for agriculture remained at only 0.05 per cent (from 79 percent in 1952 to 0.05 percent in 1998) with a massive increase in the allocation of land to land under development, to land for sale of topsoil and to land for speculation 87 percent (from 16 percent in 1952 to 87 percent in 1998). Residential (3.8 per cent), commercial (0.34 percent), industrial (0.07 percent), and roads (3 per cent) usage also showed an increase.

Table 2 indicated changes in land use dynamics in a suburban area on the East side (Klong 9-10) Agricultural area (paddy field) was also changed in the same pattern as above. Agricultural use remained at only 27.3 percent in 1998, reduced from 83.2 percent in 1952, but the residential area was not much increased, only 3.3 per cent in1998. The largest area of change was in vacant land, 56.3 percent in 1998.

Table 2 change of land Use in four study areas

Land Use Activities	Mahasawat			Bangkhu Wiang			Sai Gong Din			Klong 9-10		
	1952	1974	1998	1952	1974	1998	1952	1974	1998	1952	1974	1998
Residential	1.10	6.63	13.33	2.51	6.22	7.58	0.37	0.87	3.89	0.75	Na	3.35
Commercial	0.00	0.20	1.19	0.05	0.25	0.43	0.00	0.00	0.34	0.00	Na	0.50
Industrial	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.07	0.00	Na	0.02
Warehouse	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.04	0.00	Na	0.01
Religious	0.05	0.68	1.04	0.23	1.51	1.90	0.04	0.04	0.05	0.02	Na	0.32
School	0.00	0.34	0.40	0.00	0.76	0.77	0.05	0.25	0.41	0.00	Na	0.09
Government Office	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	Na	0.00
Agriculture	78.68	45.71	29.59	71.07	54.64	45.08	78.89	71.98	0.05	83.26	Na	27.35
Road	0.00	0.61	1.16	0.00	0.25	0.59	0.00	0.98	2.98	0.00	Na	3.64
Canal	13.24	13.24	13.24	14.08	14.08	14.08	4.65	4.65	4.65	6.74	Na	8.42
Land under developing	6.92	32.58	39.63	12.06	22.29	29.55	16.00	21.22	87.42	9.23	Na	56.31
Total	100	100	100	100	100	100	100	100	100	100	Na	100

Source: Survey by authors in 1998

Consequently, the counter force of urbanization was visible through the rural or green areas but they were not yet developed, remaining as land held for speculative development.

Consequently, the comparative analysis of land use during 1952, 1974 and 1998 in the four study areas found that the trend in changing in settlements structure were different in the four study areas. Mahasawat community, of course, was rapidly grown with 13.3 per cent of residential area remaining nearly 40 percent of land under clearance or vacant land for future housing development. Whereas the other one at urban- fringe area, had steadily grown from 2.51 percent to 7.50 percent residential areas because there was no road construction and it had a linear settlement pattern along the river, that of obviously seen 45 per cent of agricultural area had remained. On the other sides of suburban; Sai Gong Din community and Klong 9-10 community, the residential areas had also slowly increased, meanwhile an agricultural area had rapidly decreased. Land under clearance for development, of course, had sharply increased with an advent of road construction, which can reserve space for housing development in the near future (see Table 2).

Stages of transformation of settlement structure, the study illustrated the transformation process in four areas as follows: Figure 4 shows the existing land use and forms of change at the sites in urban area (Mahasawat). Land under development (vacant land) displaced agricultural areas in order to facilitate the construction of new private sector housing close to the canal sides, as residents prefer to live near a natural environment. On the other side of the canal, it is also developed by individual households through extension for accommodating larger families. Owing

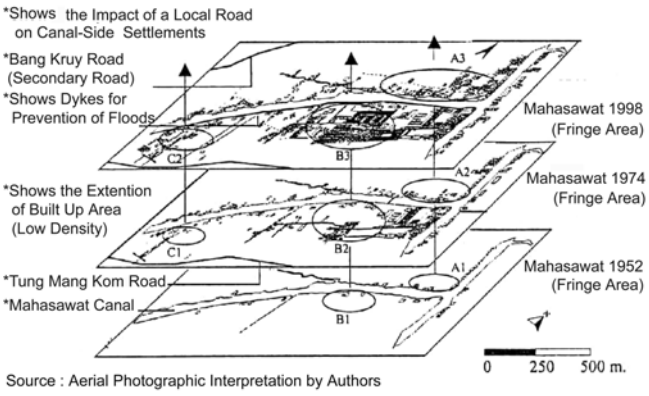

Figure 4 Change in settlement structure: Mahasawat (urban fringe area)

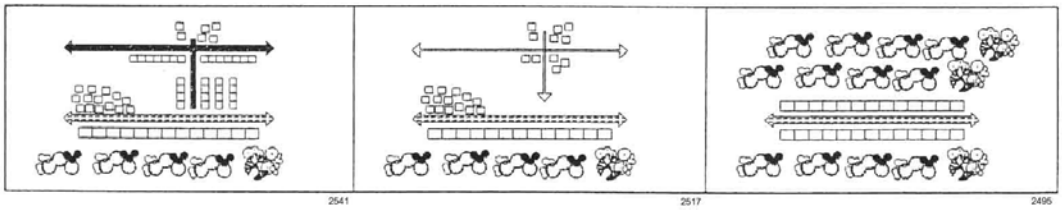

Figure 5 Transformation of settlement form: Mahasawat Community

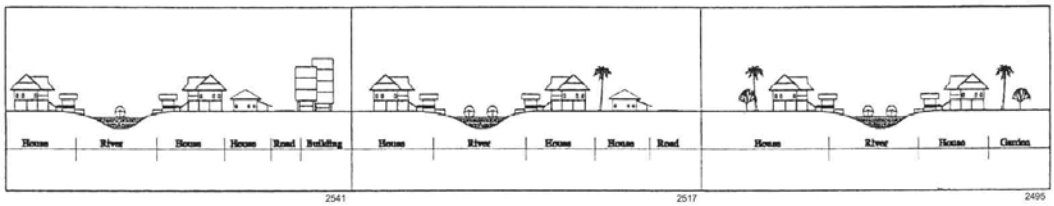

Figure 6 Transformation of house form: Mahasawat Community

to the impact of road modernization by development on the urban structure, the area between A1- A3 (from 1952 to 1998) appears as an addition form with growth or an increase in the number of houses. This form is a cluster pattern near the river. While that in B1- B3 appears as a change form of urban structure (in the area near the road) which has changed and expanded very quickly. This pattern is also found in the area C1- C2. Numbers of houses will be increased when road accessibility existed. Thus, canal-side settlements obviously change in urban structure with canal, road, land sub-division. House form changes are characterized by high-rise buildings (4-storey walk up apartments), town house estates (3-storey houses) and detached houses, which were built on land which faced the road.

Figure 7 shows that the forms of change in the fringe area (Bangkhu Wiang) were classified as the addition type by individual households to accommodate larger families and accommodate relatives. This community appears to have grown through the addition of wooden houses with high density along the canal but it grew slowly over a period of forty years. The area from A1- A3 is the location of a temple. There is an extension of the area around the temple, which has expanded very quickly. There are many newly- built concrete temple buildings. They are built in the same growth pattern (area between B1- B2 and C1- C2). The temples are central and have common use facilities for canal-side society. However, it was found that urban structural forms were not changed, because the impact of roads on the community was not a significant urban phenomenon as the community is located far from the road accessibility. Inhabitants have

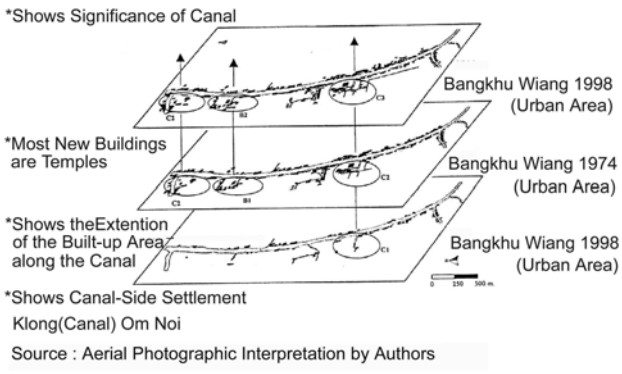

Figure 7 Change in settlement structure (urban fringe area)

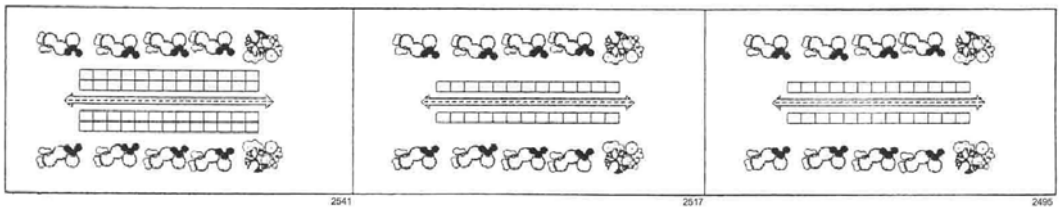

Figure 8 Transformation of settlement form: Bangkhu Wiang Community

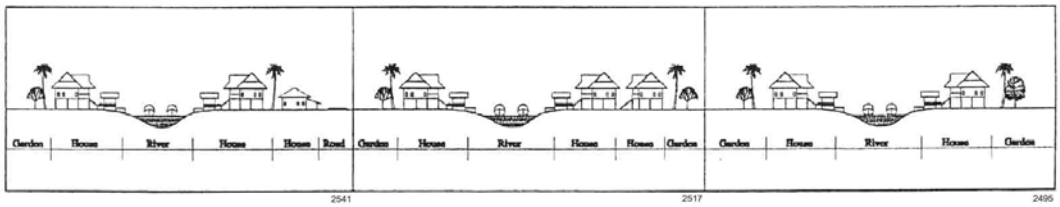

Figure 9 Transformation of house form: Bangkhu Wiang Community

to spend almost half an hour to walk outside the community.

Figure 10 shows the forms of change of the existing land use in a suburban area on the East side (Sai Gong Din) which also was classified as the addition type by individual households. The addition was around the canal near both sides of the road which is a pattern of urban growth without planning. The aerial photography interpretation shows that the advent of the road led to changes in the form of the community along the canal. Its change in form is the relocation of the community along the secondary road, as shown in A1- A3, B1- B3, C1- C3. The area A1, B1 and C1 in 1952 shows the community form when there was no road accessibility. The canal-side community was not changed until it was accessed by road in 1974, as shown in A2. It started spreading and finally completed its expansion. Housing growth started its relocation towards the road in 1995, as shown in A3, B3 and C3.

Figure 13 illustrates the transformation in suburban area (Klong 9-10), which was the relocation of individual households from along the canal to both sides of the road lying between their houses. It shows a pattern of unplanned urban growth. The result of aerial photography interpreted data shows the community form was affected by road development. The form of community change appears in settlement along the road, as shown in A1- A2 and B1- B2. However, the distance between community and road will affect the community density, since the location of A1-A2 is near the city now which has a higher density than in the area B1- B2. But it was not found that the urban structure of canal-side settlements

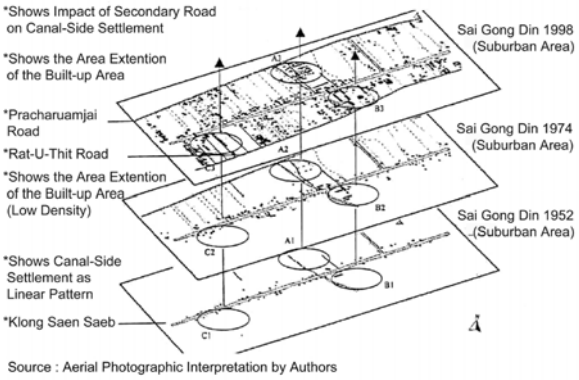

Figure 10 Change in settlement structure: Sai Gong Din (suburban area)

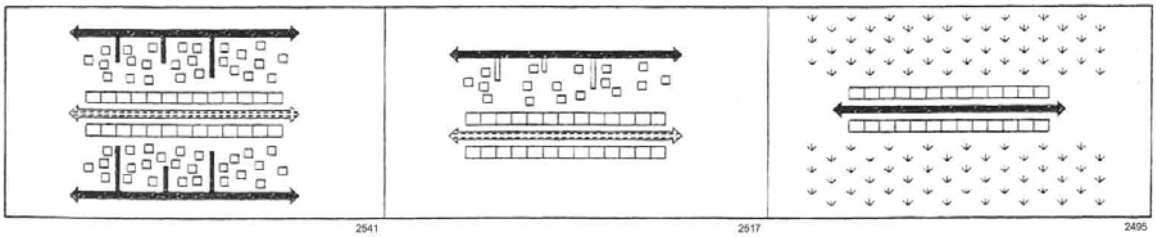

Figure 11 Transformation of settlement form: Sai Gong Din Community

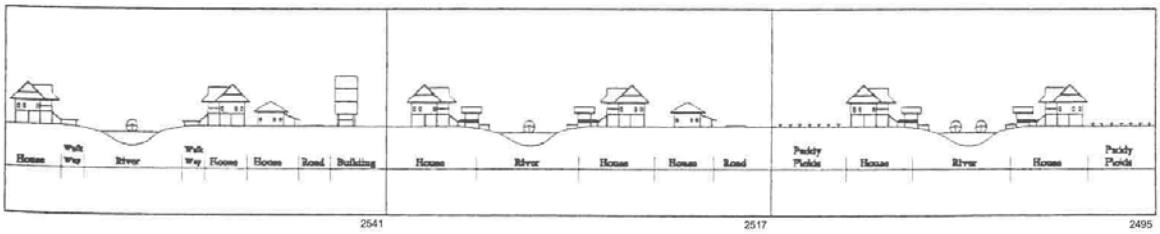

Figure 12 Transformation of house form: Sai Gong Din Community

7. FORMS OF CHANGE BY ROADS CONSTRUCTION

Generally, the change caused by road construction affected the forms was quite different nature of settlements structure. It shows that characteristic of change form is very rapidly changed by the road and the street networks with sprawl development occurred as followings:

Figure 16a, 16b and 16c indicate that canal settlements in 1952 of three areas were linear patterns along the canal, and the fronts of houses faced the waterway in one or more unplanned rows because the waterway was a main route. The settlements still consisted of agricultural areas, temples, canal houses and markets.

Figure 17a, 17b and 17c show existing canal settlements when the advent of road (since 1998) impacted on the canal house forms. There were two types of settlement found in the study; first, the settlement of houses with their fronts facing the street came at equal depth with the secondary street, which could be narrow alleys parallel to the street, and second the construction of buildings changed from old to new types.

Figure 17a shows that local roads provided the accessibility in Mahasawat (urban area) that made the settlements expand at a rather fast pace. In other words, secondary roads caused higher density in this urban structure leading to urbanization. Whereas Figure 16b (Sai Gong Din; suburban area) and Figure 17c (Klong 9-10; fringe area) show the secondary road that functioned as a linkage of the community and the arterial road that caused high density development. It

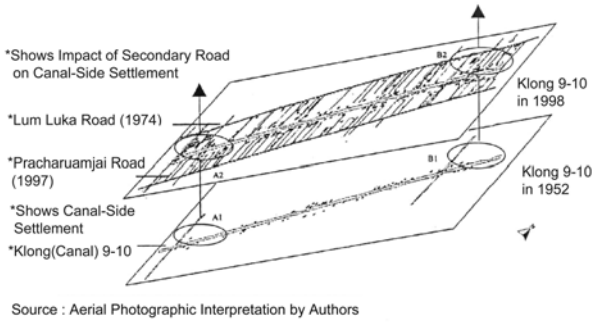

Figure 13 Change in settlement structure: Klong 9-10 (suburban area)

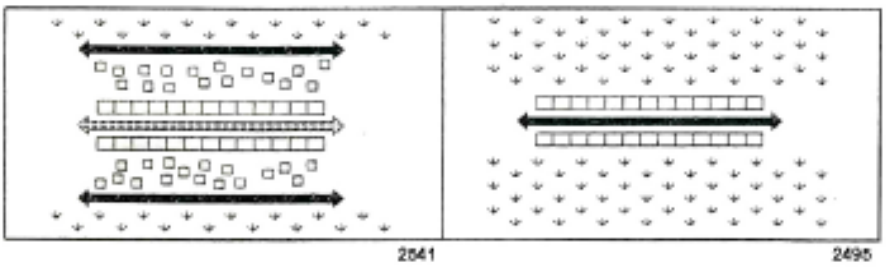

Figure 14 Transformation of settlement form: Klong 9-10 Community

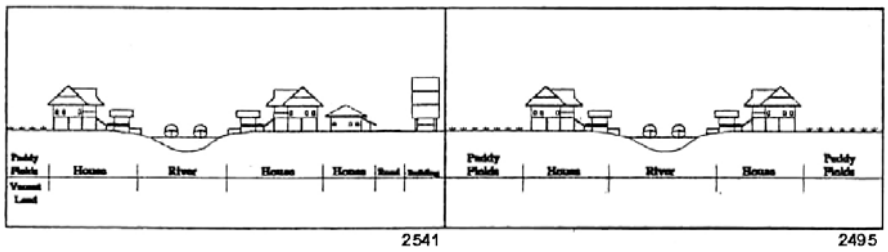

Figure 15 Transformation of house form: Klong 9-10 Community

could be said that the slow expansion of settlements in both areas was not dependent upon the secondary road but encompassed the following causative factors: (1) Distance from an arterial road (2) The Thai economic depression in 1991 did not enhance investment in land development.(3) The sub-standard infrastructure system including utilities and facilities was apparent in both areas. For example, artesian water was still used for daily life, and there was no standardized schools and hospitals for the community. (4) There was no complexity of activities in these areas. The land was mainly used for agricultural activities. Therefore, the community had a low density compared to the areas of canal communities that were easily accessible by a local road.

8. FORMS OF CHANGE IN BUILDING TYPES IN FOUR AREAS

The study shows that change in house type was from an old type to a new type; an old house type is a pillar house built with timber, but a new one was built on land with timber and concrete or only concrete. The extent of change in building types was analyzed through the use of a modern building material index and a building height index. The results from analysis of the aerial photography interpretation technique and surveyed reveal that the trend of the building types in the four areas are as follows:

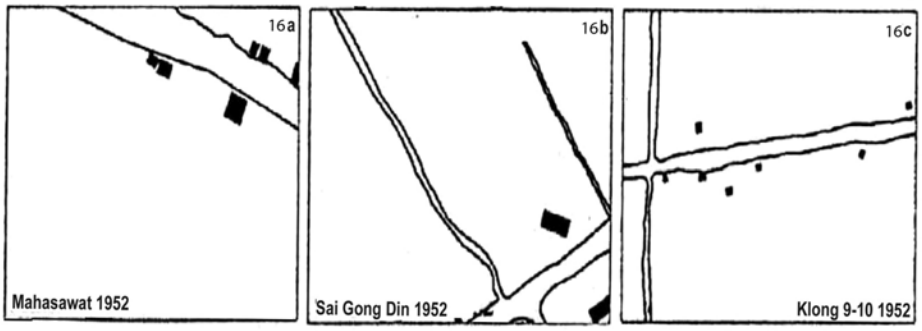

Figure 16 Existence of canal-side settlement based on canal in 1952

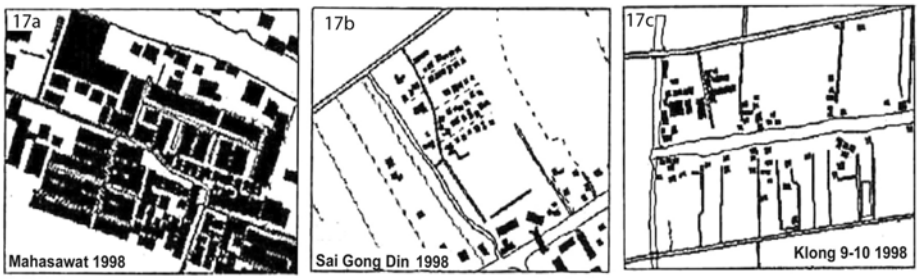

Figure 17 Existence of canal-side settlement based on road development in 1998

8.1 Change in House Construction Method and Material in Four Areas

In Mahasawat community; the result revealed that trend of house construction method was from houses built on pillars to houses built on land during 1952, 1974 and 1998. Figure 19 indicated the amount of growth in number of buildings that use modern building material (concrete) rapidly increase from 4 and 48 to 393 units meanwhile the amount of growth in number of buildings using old material (timber) has slowly increased from 51, 303 to 303 units during 1952, 1974 and 1998 respectively. Meanwhile the amount of growth in number of buildings that use old material (timber) has slowly increased form 5 to 303 units during 1952, 1974 and 1998 respectively. Regarding trend in building height, the study found an increase in number of 2 and 3 - storey houses. On the contrary, 1 storey-house quickly decreased. (Figure18)

The Bangkhu Wiang community; Figure 18 shows that modern building material (concrete) have just been found in recent times only 18 and 24 units during 1974 and 1998 respectively. However, trend in the usage of timber was steadily growing. Trend in building height was mainly the construction of one-storey houses although there were also many two-storey houses.

For the Sai Gong Din community; Figure 18 shows that modern building material (concrete) alone was not used before 1974, but trend in usage of concrete and timber have been quickly increased.

In the Klong 9-10 community; Figure 18 shows the usage of concrete for building was not found in over forty years except recently (67 units in 1998). The height of building was mainly 1-storey houses.(Figure 19)

The study indicated that the advent of roads affected change in modern building material use (concrete) and height of building. It was found that trend of change in the 4 areas were in the same direction. For example, the highest change rate of using modern material was found in the Mahasawat community, followed by the Sai Gong Din and the Klong 9-10 communities, respectively. However, since the Bangkhu Wiang still was not approached by road, the change in using modern material there increased steadily. Also, when considering trend of the building height, the study showed that there is a consistency in the increase in building height and the modern building material use. The height of buildings was speedily increased from 1 storey to 2 and 3 storeys, as shown in figure19. Briefly, the community located closer to the CBD such as the Mahasawat community has more tendency of the increase in the building height than the Sai Gong Din and the Klong 9-10 community which were further from the CBD. For the Bang Khu Wiang community, it showed a steady increase in number of buildings with more storeys. Furthermore, the area or groups of houses facing the road or close to the road showed the higher percentage of change in using modern material than those facing the water.

Figure 20 shows a comparative diagram of house transformation, and the study suggested that there are relationship between the change from waterways to road development and the change through the use of a modern building material and a building height index. These show canal house buildings with an approach to the waterway as the main road and to the rear of houses are gardens and fields, which inhabitants used for a workplace near the house.

The findings indicated that the process of transformation in the traditional house form to the new form depends upon the growth in utilization of building materials and the change from wood to concrete. The comparison of the house form transformation between

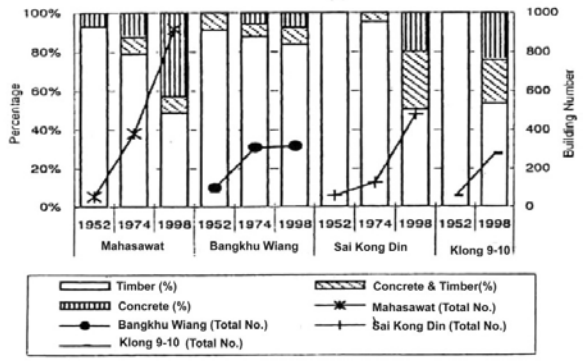

Figure 18 Trend in change old type to new type: building material used

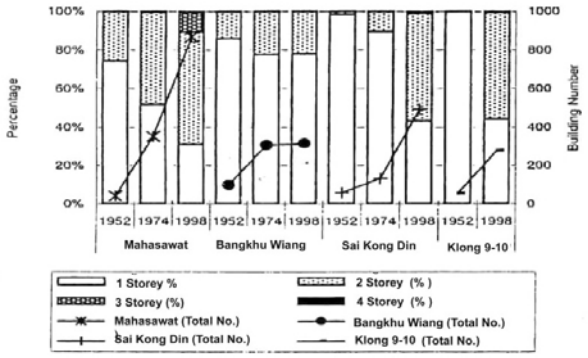

Figure 19 Trend in change old type to new type: building height

Figure 18-19 Stages of transformation process of building types

the Mahasawat community and the Bangkhu Wiang community shows that the periods of transformation in the two areas are different. In Mahasawat, it took around 20 years of transformation from houses on pillars to houses on land such as 3-storey houses in town house project and 4-storey building in walk up apartment. While in Bangkhu Wiang, it took around 40 years to develop the form of a new house type, from houses on pillars to houses on land. Moreover, the origins of the previous houses in both areas were developed from raft houses before the year 1952 (Table 3). Regarding the comparative study between Sai Gong Din and Klong 9-10 community, there was no difference in period of transformation but the house type changed from house on the pillar to on land such as 3-4 storey houses in shop houses. In the Klong 9-10, construction of houses were mainly wooden buildings of 1-2 storey houses on land.

8.2 Change in House Style in the Four Study Areas

The results from a survey in 1998, revealed that the most common house styles were the traditional Thai house style and vernacular style. Those were built on pillars in water and on land in four study areas. Especially in the Mahasawat community and the Bangkhu Wiang community on the west side, traditional Thai and vernacular houses in water were found more than in the other areas. Meanwhile modern style, meaning houses built on land, were found in the Sai Gong Din community and the Klong 9-10 community on the west side more than other areas (Table 4). The traditional Thai house styles on the West side of the Chao Phraya River are consistently related to the pattern of canal networks and their old development pattern. Modern house styles on the east side of the Chao Phraya River are related to the patterns of road networks and their new development pattern. In addition, the results from the survey illustrated modern houses and houses on land were found in road-facing houses more than water-facing houses to some extent (Table 5). Moreover, building material is consistently related to road-facing house more than water-facing house (Table 6).

The comparative study of using modern material (concrete) and house style showed that change in using modern material was more significant than change in house style. That was because the traditional house style could be preferably sustained by the house owners. However, they have accepted more the modern method of construction

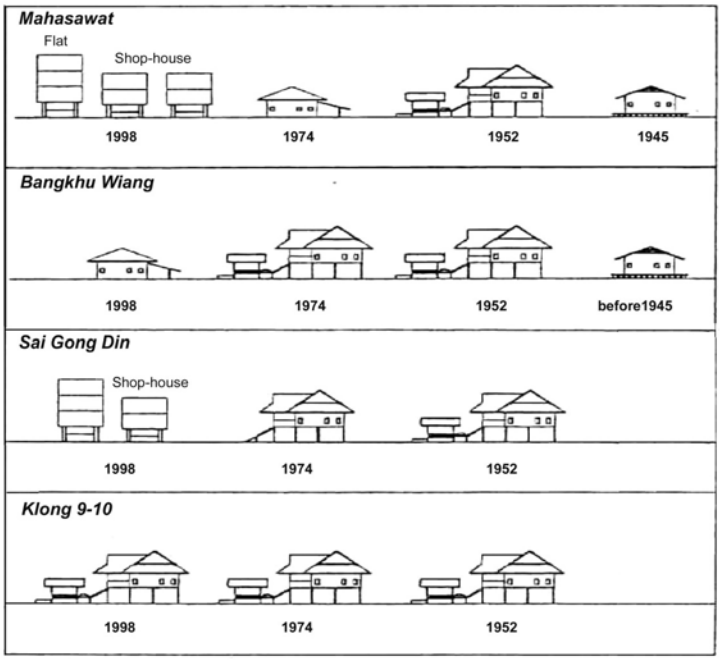

Figure 20 Process of transformation in house by case study area

Table 3 Previous house types in 1978, 4 Areas (percent)

House on the Land	Mahasawat	Bangkhu Wiang	Sai Gong Din	Klong 9-10
1. Floating House	2.0	6.5	0	0
2. Pillar House in water	74.5	60.9	68.9	25.5
3. House on Land	20.5	32.6	31.1	74.5
Total	100	100	100	100

9. CONCLUSION

This paper examined the two levels of the transformation process in canal settlement when road advent impacted. The findings of the study are: (1) structure of settlement (fabric pattern) was changed by site that was related to canal and road and community pattern. (2) building type was changed from old type to modern type or from pillar house to house on filled land. Analysis of the figure showing building material use revealed changes from using traditional material (timber) to the modern ones (concrete and timber). Further, the advent of road has brought a rapid change of building material use and building height; 1- storey houses were changed to 2-3- storey houses. Whereas, the style of house construction in the west side remained in the traditional Thai house style more than in the east side of the Chao Phraya River, despite the closer location, owing to the existence of pattern of canal networks that affected building type (pillar house style), which was well- adjusted to the environments without any additional cost for construction. Furthermore, from the survey it was found that the house owners of the newly built houses in these areas preferred to follow their relative's house styles that mostly were old style. However, the study showed the trend towards using modern material, which was higher than the old or

Table 4 House style by location areas (percent)

House Style	Mahasawat	Bangkhu Wiang	Sai Gong Din	Klong 9-10
1. Vemacular house in water	57.4	54.8	3.3	25.5
2. Vamacular house on land	10.6	2.0	41.2	37.5
3. Traditional Thai house in water	21.4	21.6	3.9	4.2
4. Traditional Thai house on land	6.4	-	3.9	4.2
5. Modern house	4.2	4.6	27.7	16.6
Total	100	100	100	100

Source: Surveyed by authors in 1998

Table 5 House style by group of road and water facing house (percent)

House Style	Road Approach	Water Approach
1. Vemacular house in water	44.3	46.2
2. Vamacular house on land	25.3	20.7
3. Traditional Thai house in water	5.1	12.0
4. Traditional Thai house on land	2.5	2.4
5. Modern house	22.8	18.7
Total	100	100

Source: Surveyed by authors in 1998

Table 6 Building material use houses facing road and water (percent)

Building Material	Road Approach	Water Approach
1. Timber	39.2	57.7
2. Timber and Concrete	58.2	39.9
3. Other	2.5	2.4
Total	100	100

Source: Surveyed by authors in 1998

traditional ones, because of the process of constructing houses; on pillars changed to on filled land and the value of inhabitants which preferred modernity to economical reasons. The process of constructing houses; on pillars changed to on filled land took a different period of time to change. The community located near the CBD took a shorter time to change than those far from the CBD and facing the water, such as the Sai Gong Din and Klong 9-10 communities.

Acknowledgements:

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[1] Canal-side settlements in this study the operation definition is an area of settlement restricted to a depth of approximately 200 meters from the canal bank and it is on both side of canal.

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[12] Mahasawat canal was intended to be the short-cut route. It provided for transportation of product such as rice and sugarcane, between Nakorn Chaisri and the capital, Bangkok, as well as to bring adjacent land under cultivation from near the Bang Kruai short-cut canal Northeast of Bangkok to the Tha Chen South of Bangkok. The canal was constructed by 27 km in lenght, 14 and 3 m. deep in 1860.

[13] Om Noi River was impacted from the short-cut canal, and the direct flow of the waterway in canal was very forceful and its bank was encroached until it became the river, while the original river became shallow and narrow which was called "Canal" (klong) Klong Om Noi

[14] Klong Sean Seab was dug in 1837-1840 for a military purpose. Linking Bangkok and Chachoengsao Province with the Bang Pakong River, these canals are 12 meters wide, 2 meters deep and have a combined length of 53.5 kilometers. There are numbers of communities and temples along the canal.

[15] Klong Hok Wa named by its width (6 wah or 3 meters). It consists of 15 sub-klongs (klong 1 to klong 15) start trip from Sapan Mai Don-Muang to Nakorn Nayok province.