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LANDSCAPE HYDRO-ECOLOGICAL INFRASTRUCTURE OF BANGKOK'S WATERSCAPE URBANISM

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Abstract

Bangkok presents a degraded, but still vibrant indigenous form of water-based urbanisation as a model of resilience and adaptability developed in concert with the predictable cycles of monsoon rains and wet rice cultivation. The hydrological matrix created by the landscape hydro-ecological infrastructure provides tangible evidence of the region's larger hydrological cycles as well as the details of every-day life in the historically urbanized delta. The city's modern rapid urbanization brought land-based infrastructure and other modern constructions that resulted in a rapid increase in built up areas at the expense of cultivated land and the hydrological matrix. Many canals were filled in for development or replaced by the construction of new roads. Many others became stagnant and non-navigable, were reduced to drainage ditches or open sewers. These liquid networks, once considered a lifeline, became much neglected and ignored, yet they continue to exist in many areas. However, the major mechanism that keeps the delta habitable and prolific has been damaged. Landscape porosity is a critical element of landscape structure and function of the deltaic landscape and is perceived as "landscape hydro-ecological infrastructure" and "ecological services" have been severely diminished. Combining new ways of looking at the landscape, new ecosystem science and the case study of the Bangkok, landscape hydro-ecological infrastructure provides an argument and a redefined concept of waterscape urbanism central to addressing the environmental and social challenges of Bangkok's urban ecosystem today.

Keywords: Landscape, Hydro-Ecological Infrastructure, Waterscape, Bangkok, Urbanism

INTRODUCTION: The Landscape of Chao Phraya River Delta

Bangkok, the capital of Thailand, is situated in Southeast Asia's tropical monsoon belt on a slight deltaic high amidst the predominantly low lying, flat terrain of the lower Chao Phraya River Delta. The alteration of the delta landscape in the form of lands reclamation by the construction of extensive canal networks as a landscape hydro-ecological infrastructure during Bangkok's early days turned the swampy land into the prolific producer by the way of irrigation and drainage. The networks also functioned as a highway system, providing accessibility to land. Absorbing, distributing and retaining water during the dry season and draining excess water during wet season.

Landscape Structures

The rice growing landscape and society of the Chao Phraya River delta's is a complex socio-economical-ecological relationship of structures, functions and changes (Ishii, 1978 and Brummelhuis, 2007). Founded upon the condition of climate (Kyuma, 1978), topography (Takaya, 1987) and soil (Hattori and Kyuma, 1978) the low land/wet rice

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Figure 1: The watery Chao Phraya Delta with Bangkok sprawling into rice fields to the east and fruit orchards on the west bank. (source: The Global Land Cover Facility (GLCF), University of Maryland http://glcf.umiacs.umd.edu/index.shtml)

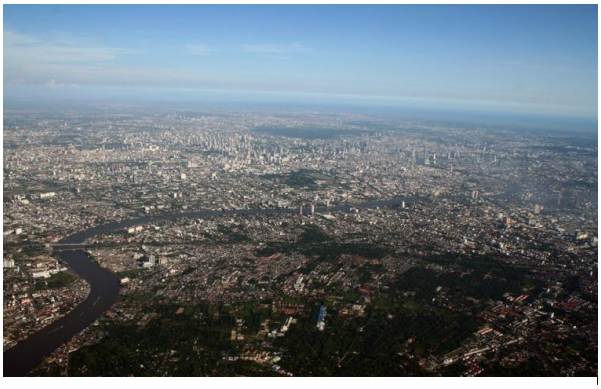

Figure 2: Bangkok's urban – agriculture - rural mosaic (Source: Ying Pongkajonkijkan)

cultivation has been adopted in according with nature (Hattori and Kyuma, 1978). People evolved together with the landscape through rice cultivation with indispensable water into a rice-economy (Ishii, 1978). The rice-economy was significantly influence by water availability, thus traditional water management, was in place for distribution of water and flood control on a small scale according to hydrological and topographical characteristics with unique local and social organization (Ishii, 1978 and Brummelhuis, 2007).

The topography of low-lying flat terrain has an elevation of less than 2.5 meters with virtually no gradient. The landscape of the area is greatly dominated by these hydro-ecological characteristics that compound the flood conditions severely. As a result, draining excessive runoff is very difficult.

Landscape Functions

The lower part of the Chao Phraya River, the geomorphologically younger part of the delta, is a part of "the center of the geographical living space" of Thailand (Tanabe, 1977). This view was built upon the capability of the landscape to provide functions or potentials for human inhabitation and exploitation, such as the capacity to produce food and resources, the capacity to build human homes and other buildings, a self-regulated environment, based on the resilience of the landscape's ecosystem and the capability to be linked with aesthetic, scientific, cultural and other aspects of human needs (Zonneveld, 1988). The landscape hydro-ecological infrastructure such as the meandering river and an endless network of natural streams and manmade waterways comprise a distributary network rather than tributary geography in the Chao Phraya Delta. Bringing and retaining the water during the dry season and draining the water during wet season, the vast network of canals brings life to the urbanized delta. The vast network of canals brings tangible evidence of the region larger hydrological cycles to the details of every-day life in the historically urbanized delta. The agricultural land such as paddy rice fields benefit people by contributing to water management. The role of paddy rice fields in water management (Sathianpantarit et al. 2000 after Yuyama et al. 1996 and Yuyama 1999) are:

1. *Flood mitigation as retarding basin*
2. *Water resources for downstream area as regulating pond*
3. *Water quality and ecosystem conservation*
4. *Prevention of soil erosion*
5. *Production of oxygen*
6. *Provision for recreational opportunities.*

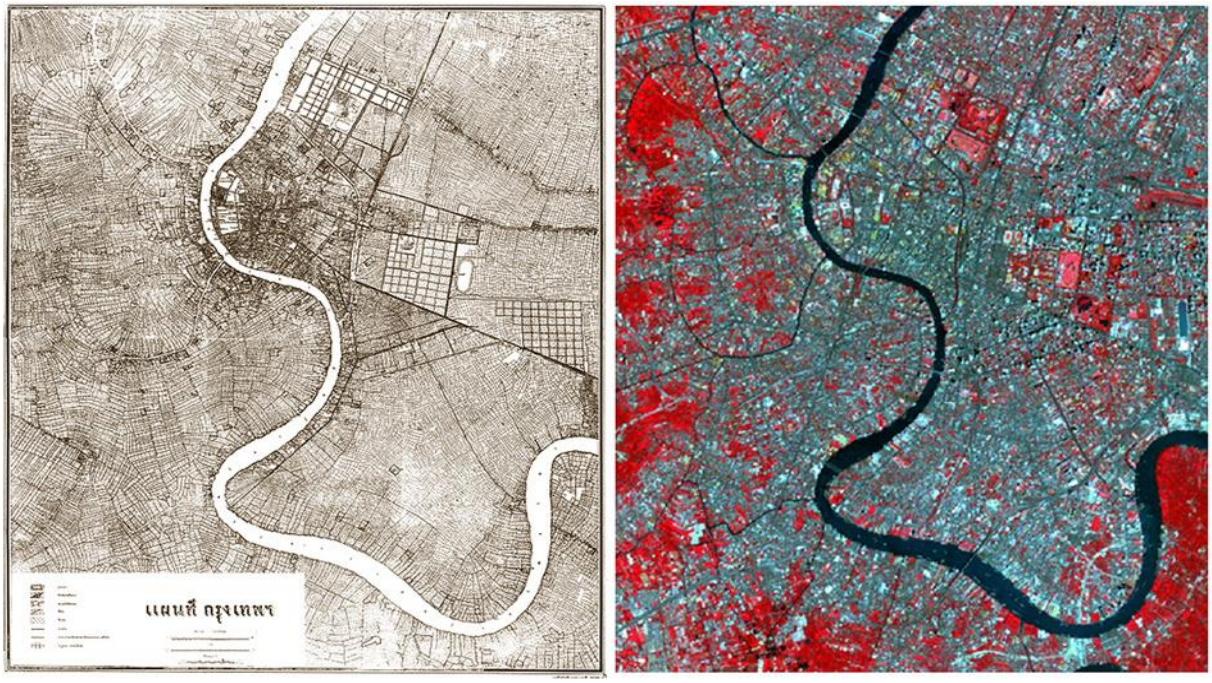

Figure 3: Bangkok circa 1890 (left) and 2004 (right) (False color ASTER vnir Image): the two views show how the Bangkok urban morphology follows the pattern of water-based rice and fruit framing
(Source: Bangkok circa 1980 Map: Larry Sternstein, 1982. Portrait of Bangkok, Bangkok ASTER VNIR image: The acquisition of ASTER data was supported by a research project, 'Investigation of Rapid Urbanization Processes Using ASTER, MODIS, and Landsat Data', by Dr Philip Christensen, Principal Investigator, NASA Grant number: EOS/03-0000-0502.)

Landscape Changes

In former times in Bangkok, land reclamation for rice culture and human settlement was the major alteration of the deltaic landscape. The construction of vast canal networks was the part of the process of turning the swampy land into a prolific producer by way of irrigation and drainage (Takaya, 1987). The canal network also functioned as a highway providing access to the surrounding area and beyond as far as the waterways went (Takaya, 1987). This process of landscape change continued until the end of the Second World War. The Chao Phraya River and its network of canals were lifelines for Bangkok's residents. People lived in concert with the natural cycles of flooding as a part of their lives. Adaptation was the key in living with the rhythm of hydro-ecological dynamics by building their living environment without damaging the course of the natural processes. The inhabitants of the Chao Phraya Delta have been through long periods of resilience and adaptation in dealing with various kinds of landscape change. The complex distributed city of orchards, rice, fish and prawn farms, as well as electronics and automobile factories now face new challenges related to climate change, lands subsidence and rising sea levels.

Waterscape Urbanism

The area was first urbanized during the Ayutthaya period (1350-1767) as a vast network of mixed fruit orchards and market towns planted within a harsh marshland (Tachakitkachorn, 2005). The rapid development of the lower delta for export rice cultivation affected the rapid urbanization of the city of Bangkok (Takaya, 1987). In the early years, many canals were constructed and functioned as highways (Takaya, 1987). The canals radiated outward from the center of the city, providing access to the city center as well as the agricultural market towns along the waterways. Along the canal banks were

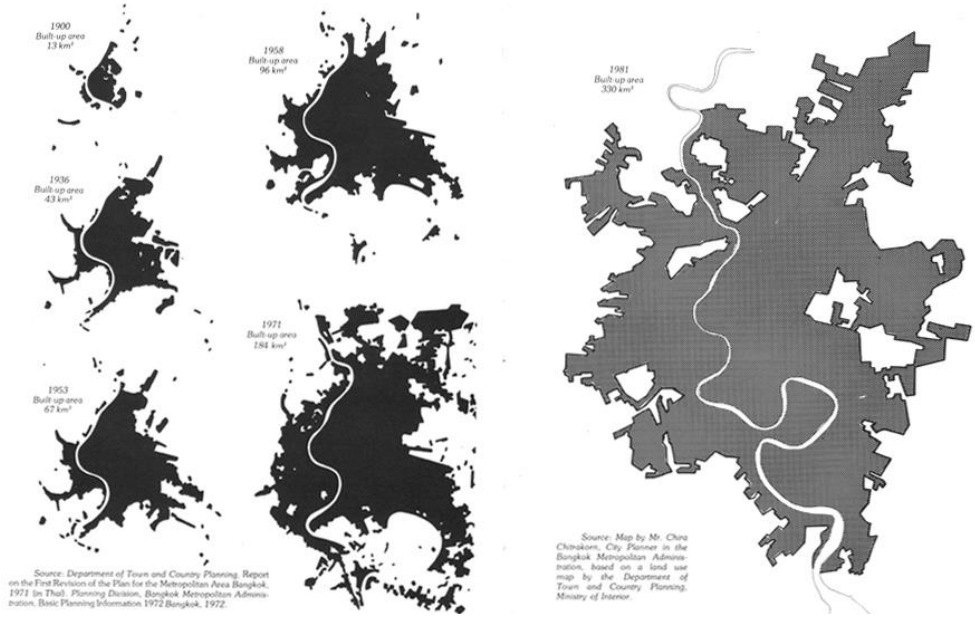

Figure 4: The growth of Bangkok metropolitan area during 1900-1981 (Sources: Sternstein 1982)

homes, shops and other buildings. The lands in between were fruit orchards and rice paddies. The early residents relied upon canal and river water for their basic needs (Jarupongsakul and Kaida, 2000).

In the early period of city establishment (1782-1900), Bangkok grew rather slowly. Rapid urbanization and increase in population started after the Second World War (BMA, 2004). These rapid changes brought the number of land-based infrastructure and other constructions that resulted in a rapid increase in built up area (BMA, 2004) at the expense of cultivated land and the hydrological matrix. The swift expansion of Bangkok's industry and suburban development occurred in the late 1960s and 1970s. As a result, the growing demand for housing sprawled eastward into the paddy fields (Jarupongsakul and Kaida 2000). The growth of the nation and the city brought rapid urbanization to the low-lying flat terrain of the lower Chao Phraya Delta. Once considered unsuitable for human habitation (Takaya, 1987). Bangkok has since grown into a tropical megacity.

The rapid urbanization also affected the city's unique vast canal network which became secondary to the construction of roadways through the rapid urbanization. The network once considered a lifeline has been neglected and abandoned (Jarupongsakul, 2000). The plight of climate change compounds an already complex ecosystem with many conflicts between delta and the city dynamics. The major parts of urban growth are concentrated in the transition between the inner city and the outer part or suburb area. This urban-rural intermixed area can be characterized by the sprawl of old and new residential estate developments, clusters of industrial estates, strip developments of commercial areas along the roads and large shopping centers. These urbanized areas situate in the old agricultural areas that can be viewed as the pattern of patchy human developments in the matrix of agricultural and open fields. The major mechanisms that keep the delta habitable and prolific has been damaged (Jarupongsakul, 2000) and creates hardships for the many farmers who continue to rely on the waterways. Many canals were filled in for development or replaced by the construction of new roads, while many others became stagnant and non-navigable, reduced to drainage ditches and open sewers.

EMPERICAL: Vanishing Hydro-Agricultural Landscape of Bangkok,

The low-lying flat terrain of Bangkok's land-based urbanism are dictated by the tropical monsoonal climatic conditions and coastal tidal dynamics. The city is under the threat of flooding at the height of the rainy

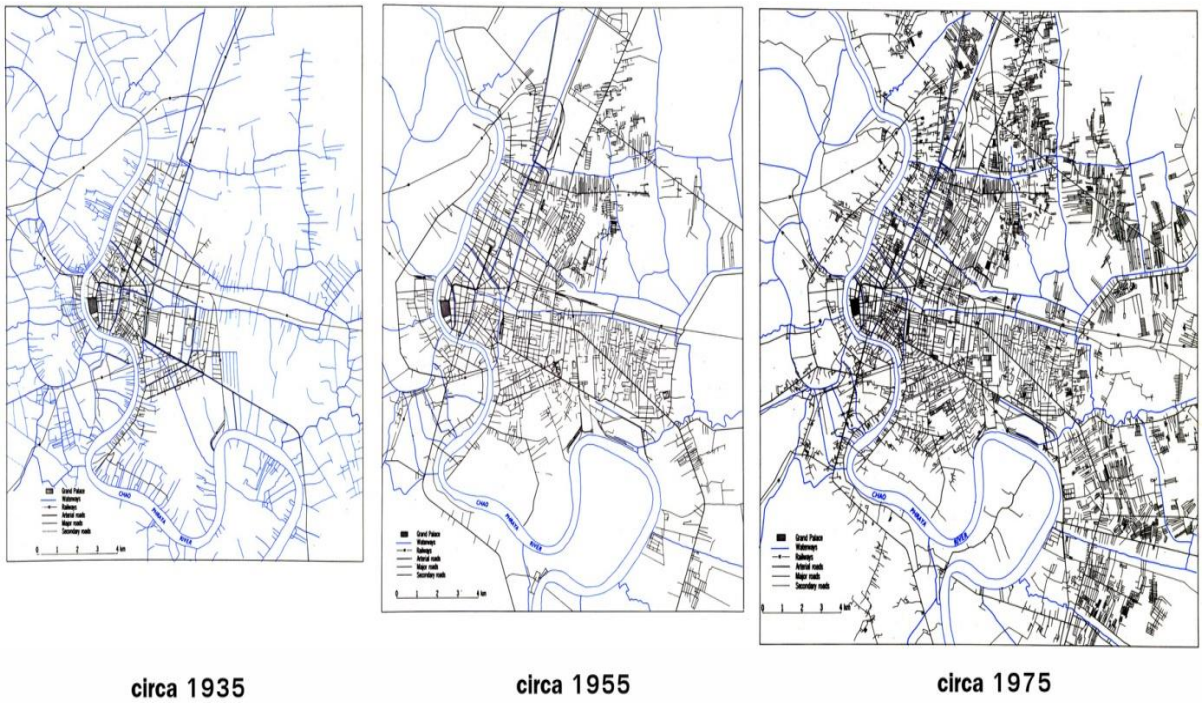

Figure 5: The vanishing land and waterscape: rapid changes have brought the amount of land-based infrastructure and other structures that resulted in a rapid increase in the built-up areas at the expense of cultivated land and the hydrological matrix (adapted from Sternstein 1982). Since 1950, road building has far out-paced canal digging which was the dominant infrastructure for transport in the previous centuries of delta habitation (adapted from Sternstein 1982). The result is a two-level transport network where land-based infrastructure dominates and comprises the ability of the hydrological network to operate. In the rainy season, the opposite is often the case as annual floods slow and stop traffic in much of Bangkok. (Source: The triptych of maps from 1935: 55 and 75, adapted from Sternstein 1982)

season. The excessive flow generated by the rainfall in the upland watershed of the Chao Phraya River combines with the excessive runoff created by the rainfall in Bangkok and its surroundings often puts many parts of Bangkok under water. The high tide that slows down the flow of the river compounds the draining of excessive runoff which is impossible without the help of modern technology such as floodwalls and pumping stations. These three hydro-ecological characteristics greatly dominates the landscape which has been given the symbolic name of Bangkok, "the city of three waters" (Jarupongsakul, 2000). The lack of recognition of natural hydrological processes and the indigenous and traditional knowledge of living in concert with natural cycles of wet and dry seasons present the delta and the city as threats to each other. The dynamic of space-time relationships of human and nature has failed to recognize the importance of the hydro-ecology of the landscape of the city. The vanishing views of natural processes and the vanishing land and waterscape that reflect the relationship between human and natural processes of living with water are clearly visible in the Bangkok metropolitan area. These views are also reflected in the recent transformation of agricultural areas to built-up areas in the urban fringe of the metropolitan area. As consequences of these different views, the roles and functions of natural processes and the landscape are perceived differently. These different values play a major role in dictating different changes in the land and waterscape and land and water use. The encroaching of agricultural land by development is increasing at alarming rate. Consequently, "landscape porosity", a critical landscape structure and functions of the deltaic landscape which perceived as "landscape hydro-ecological infrastructure" and "ecological services" have been severely diminishing.

Diminishing Landscape Hydro-Ecological Infrastructure and Services

The loss of landscape hydro-ecological infrastructure such as rice paddies, mixed-fruit orchards and the water matrix of canal networks affected landscape porosity and other ecological functions or ecological services (Sathianpantarit et al., 2000 after Yuyama et al. 1996 and Yuyama, 1999, Palopakon, 2009, Sri Thanyarat, 2009). Food production, water resource regulation, retarding the basin and regulation ponds, water retention and infiltration, water quality and conservation - reservoirs and filters, soil erosion protection, oxygen production and microclimate control.

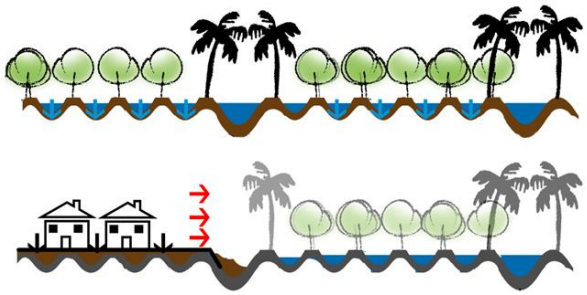

Figure 6: Porous Mixed-fruit orchards transformation
(Source: Palopakon, 2009)

Bangkok Urban Ecosystem

Contemporary ecological thinking has been radicalized through new, open, non-equilibrium disturbance models. Rather than seeing ecologies as closed systems in balance, ecosystem science today conceives of the world as an open, impermanent system of patches in flux (McGrath, et. al, 2008).

The Chao Phraya River Basin is the regional environment within which the historical, geological, topographic and climatic conditions of Thai urbanism can be understood within a watershed framework reconceived in an era of global tourist and media flows. Also, it is a dynamic social patchwork, continuously transformed by a distributed network of human agents operating within fluctuating political, cultural, hydrological and market conditions (McGrath, 2012).

The social science framework for this study, the Human Ecosystem Framework, links critical biophysical resources to social systems through the flows of individuals, energy, nutrients, materials, information and capital. In urban ecosystem science, both urban and rural patterns are recognized as re-combinations of vegetative and built patches structured by watersheds identified as Patch Dynamics (Shane, 2005, McGrath, et. al, 2008). Urban ecological structure and performance is understood through measuring inputs and outputs of flows through relatively small, bounded patches over time.

This paper seeks to understand ecosystem processes and connective logics across scale and time, rather than defining historically discrete or topographic limits to urban ecologies or architecture. Contemporary ecological frameworks – watersheds, human ecosystem and patch dynamics - are employed here in order to understand contemporary Bangkok as part of an emergent human ecosystem while Bangkok's three ecologies are presented as new design models for confronting the primary environmental, social and psychic dilemmas present in 21st century urbanism.

DISCUSSION & RECOMMENDATION: Waterscape Urbanism: Planning and Design for Urban Resilience

At present, the Chao Phraya River Basin is managed by a vast network of hydro-electrical and draught control dams and reservoirs by ministries in Bangkok rather than tributary kingdoms. Modern dams and huge reservoirs replaced cities as locally controlled and maintained water retention systems modeled on the Tennessee Valley Authority with World Bank and American assistance during the Cold War. Water and floods were thought to be technologically controllable and manageable in a system that is more ideologically aligned with techno-rational models than with the complexities of indigenous Thai socio-hydrology and urbanism.

Figure 7: Porous Mixed-fruit orchards transformation, 1952-2002-2006
(Source: Palopakon, 2009)

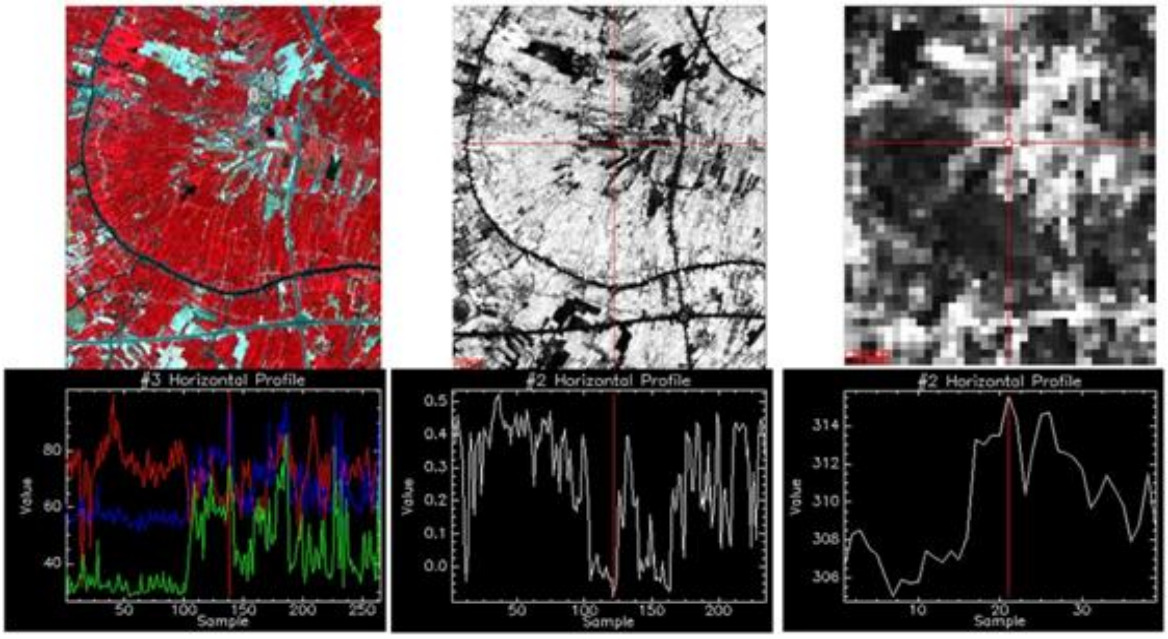

Figure 8: Urbanized lands in porous mixed-fruit orchards area: vegetation covered area vs. built up area and vegetation index and surface temperature comparison
(Source: Srithanyarat, 2009)

Contemporary Bangkok might look to the historical context of Thai waterscape urbanism for solutions to the pressing problems of vanishing urban agricultural land and climate change: a pre-modern, locally controlled, human ecosystem watershed model structured and sustained Thai cities for centuries. A reassessment of how river and water flows have been adjusted to pass around and through cities rather than flushed under them is critical in order to create new dynamic design models of urban ecosystems. The understanding of historical resilience and adaptability of living with water of indigenous and traditional processes would be crucial for dealing with future uncertainty. This is not just a historical model, but contemporary urban ecosystem designs around the world are looking for ways to retain water in cities (McGrath, et. al, 2008). Contemporary urban ecosystem science and Thai urbanism both point to the creation of cities as water retention systems for socio-cultural as well environmental reasons.

Envisioning urban resilience, McGrath and Thaitakoo (2005) suggest:

- Comprehending the city as an ecosystem - the biophysical and socio-cultural life-support conditions of a city
- Localized strategies must be deployed on the ground
- Revaluation of pockets of the city's hydro-agricultural fringe in order to provide breathing space, temperature moderation, water-quality maintenance and new perspectives is of critical importance
- Cultural production of localities within such disjunctive flows is quite complicated work, and requires new collaborative tools developed between design, education, ecology, and social research.
- Careful reexamination of the historical resilience and adaptability of living with the nature of indigenous knowledge and local wisdom would be crucial for dealing with future uncertainty such as climate change
- A bottom-up approach for emerging democracies and sustainable community development
- Recognizing patchy rather than centralized urban development, localized air-, water- and food-quality management could be strung among the under-utilized open spaces concentrated on the orchard meanders and the long, ancient irrigation canals, made visible and publicly accessible
- Physical connections provide feedback loops between farmers, consumers and policy-makers
- This is not just an engineering solution towards sustainability, but the recognition of a patchy new symbolic realm as well as a new cultural space where water and agricultural lands can become the fuel source for the mobile culture on both roads and canals to reweave the geo- and aqua-bodies into a new cultural landscape.

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Figure 2, Ying Pongkajonkijkan

Figure 3, Bangkok circa 1980 Map: Larry Sternstein, 1982. Portrait of BangkokBangkok ASTER VNIR image: The acquisition of ASTER data was supported by a research project, 'Investigation of Rapid Urbanization Processes Using ASTER, MODIS, and Landsat Data', by Dr Philip Christensen, Principal Investigator, NASA Grant number: EOS/03-0000-0502.

Figure 5, The triptych of maps from 1935, 55 and 75, adapted from Sternstein 1982.