Bangkok's Green Infrastructure
โครงสร้างพื้นฐานสีเขียวกรุงเทพมหานคร

Sirintra Vanno
สิรินทรา วัณโณ

Faculty of Architecture, Chulalongkorn University, Bangkok 10330, Thailand
คณะสถาปัตยกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย กรุงเทพมหานคร 10330
E-mail: sirintra.v@chula.ac.th

Abstract

Infrastructure is the basic foundation of all civilized urban settlements around the world, reflected in each city's lifestyle and quality of life. Infrastructure is organized around utilities and facilities that connect every part of the city together. Typical infrastructure includes roads, water supply, sewers, power, telecommunications, etc. A city's urban infrastructure system is much more complex in terms of the many levels of developments underneath the ground, on the ground, and up in the air to facilitate transportation and communication. Multi-functional areas serve people's needs at the same time.

Green infrastructure is an interconnected green space network that is planned and managed for its natural resource values and is related to urban ecology. Bangkok has green infrastructure that we need to protect in the long term. With the growth of a fast expanding city like Bangkok, we seem to have forgotten our cultural and historic way of living in a city once well-known as the "Venice of the East". Nowadays, our canals have been replaced by roads and boats have been replaced by cars. The city has been developing so fast, without any planning on the use of green infrastructure. Bangkok's green infrastructure could be an integrated network of green spaces for our sustainable future.

บทคัดย่อ

ทุกเมืองที่มีอารยธรรมรอบโลกมีโครงสร้างพื้นฐานของเมืองที่ดีที่สะท้อนให้เห็นวิธีการดำเนินชีวิตและความเป็นอยู่ที่มีคุณภาพ มีการจัดการโครงสร้างสาธารณูปโภคและสาธาณูปการที่เชื่อมส่วนต่าง ๆ ของเมืองเข้าด้วยกันไว้อย่างมีระบบ โครงสร้างพื้นฐานของเมืองส่วนใหญ่ ประกอบด้วย ถนน ประปา ระบบระบายน้ำ ระบบบำบัดน้ำเสีย ไฟฟ้า ระบบโทรคมนาคม และอื่น ๆ แต่สำหรับเมืองที่มีการพัฒนามาก ระบบของโครงสร้างพื้นฐานของเมืองจะมีความสลับซับซ้อนหลายชั้น ตั้งแต่ใต้ดินขึ้นมาถึงบนดินและในอากาศเพื่ออำนวยความสะดวก และตอบสนองความต้องการในการคมนาคมและสื่อสารของคนเมือง พื้นที่หลายแห่งต้องรองรับกิจกรรมที่มีความหลายหลากได้ในเวลาเดียวกันเพื่อตอบสนองความต้องการของประชากร

โครงสร้างพื้นฐานสีเขียว (green infrastructure) เป็นพื้นที่สีเขียวที่เชื่อมโยงถึงกัน เป็นเครือข่ายที่มีการออกแบบวางผัง และการจัดการคุณค่าของทรัพยากรธรรมชาติและความสัมพันธ์ของระบบนิเวศเมือง โครงสร้างพื้นที่สีเขียวของกรุงเทพมหานครที่เป็นเครือข่ายที่ควรจะมีความยั่งยืน และสมควรที่จะได้รับการปกป้องในระยะยาว จากการขยายตัวของเมืองที่มีการเติบโตอย่างรวดเร็ว เช่น กรุงเทพมหานคร การพัฒนาเมืองกรุงเทพฯ อย่างที่เป็นอยู่ทำให้เราเหมือนจะลืมข้อดีของความเป็นอยู่ที่เป็นวัฒนธรรมในอดีตไป ทั้ง ๆ ที่กรุงเทพฯ เคยได้รับการขนานนามว่าเป็น "เวนิสแห่งตะวันออก"

แต่ปัจจุบัน แม่น้ำ ลำคลอง ได้ถูกทดแทนด้วยถนน และเรือถูกทดแทนด้วยรถยนต์ การพัฒนาเมืองที่เกิดขึ้นอย่างรวดเร็วและไร้ทิศทาง ไม่มีการวางแผนเผื่อการใช้โครงสร้างพื้นฐานสีเขียวในอนาคต ทำให้โครงสร้างพื้นฐานสีเขียวที่มีอยู่ถูกละเลย ไม่มีการใช้งานอย่างมีประสิทธิภาพ ดังนั้น จึงควรจะมีแนวความคิดในการพัฒนาเมือง โดยนำโครงสร้างพื้นฐานสีเขียวมาใช้อย่างผสมผสานเพื่อให้เกิดเป็นเป็นเครือข่ายพื้นที่สีเขียวที่สามารถเป็นทำหน้าที่ดูแลเมืองได้อย่างยั่งยืนต่อไป

Keywords

Green Infrastructure (โครงสร้างพื้นฐานสีเขียว)
Integrated Network (เครือข่ายบูรณาการ)
Landscape (ภูมิทัศน์)
Infrastructure (โครงสร้างพื้นฐาน)

1. Introduction

Ideally our lives should be surrounded by green assets which enrich our city, such as parks, open spaces, and recreational areas for leisure. Furthermore, there are the larger green systems, such as rivers, lakes, wetland, woodland, and many more that intersperse and are connected to cities as our *Green Infrastructure.* These green elements perform a vast range of benefits and functions to help support our city.

Bangkok, the capital of Thailand, is one of the fastest growing cities in Southeast Asia. It is located right in the heart of country. Bangkok was known as the "Venice of the East" in the past for its canal system, when we used canals as a major means of transportation to transfer goods. This old system of transportation is now forgotten as the development of new infrastructures has replaced the old canal systems of the city.

Cities like New York, London, Cairo, Barcelona, and many others are focusing on their water front and its functions. Does every city around the world want to use their green infrastructure to intervene in the existing urban landscape? A city's green infrastructure projects are all about urban revitalization, shifting away from urban recreation to a more functional green infrastructure. What can Bangkok do to uplift our city?

2. Bangkok's Green Infrastructure Approach

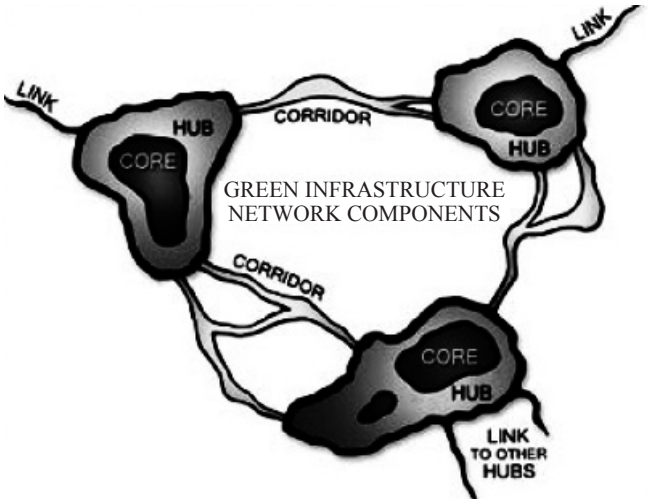
Green infrastructure is an opportunity to improve the quality of life of Bangkok's citizens and to optimize the integration with the existing traditional grey infrastructure. This paper intends to point out the opportunities for Bangkok to develop green infrastructure from the existing green areas spread out around the city, with reference to the following issues:

1. What is Green Infrastructure?
2. Bangkok Today
3. Bangkok's Grey Infrastructure
4. Where is Bangkok's Green Infrastructure?
5. Bangkok's Future

1. What is Green Infrastructure?

Used as a noun, green infrastructure refers to a network of interconnected green spaces (including natural areas and features, public and private conservation lands, developing lands with conservation values, and other protected open spaces) that is planned and managed for its natural resource value and for the associated benefits it confers on the human population. Used as an adjective, green infrastructure describes a process that promoted a systematic and strategic approach to land conservation at the national, state, regional, and local scales, encouraging land-use planning and practices that are good for nature and for people. (Benedict & McMahon, 2006, p. 3) (Figure 1)

The concept of green infrastructure does not apply to any particular municipality but to the whole system of an integrated network of sustainable green spaces. Thinking of green infrastructure in solely ecological terms is no longer appropriate for larger cities. Green infrastructure has also become linked to the economic sustainability of the city and can lead to Low Carbon City Development. A city like



Sourse: The Conservation Fund, 2011

Figure 1. The foundation of green infrastructure network.

Bangkok has an alarming rate of development and population growth. We have not thought about how to use our city's natural resources such as wetlands, street trees, urban parks, and their ecosystems in sustainable ways to support our living environment effectively. Environmental concerns and the concept of a sustainable city can no longer be treated as a future plan, but must be turned into a priority policy for each city to act and implement. Authorities will need to urgently raise people's awareness of environmental issues. People have to be aware of the benefits and how important a city's natural resources are for a city.

"A connected system of parks and parkways is manifestly far more complete and useful than a series of isolated parks" — John Olmsted and Frederick Law Olmsted Jr. 1903"

Green infrastructure is a new technical term, but it is certainly not a new idea. Olmsted, the founding father of landscape architecture, mentioned this idea back in 1903, 109 years ago. Olmsted's design concept still applies today. Green infrastructure has its origin in two important concepts:

1) Linking parks and other green spaces to benefit people.

2) Preserving and linking natural areas to benefit biodiversity and counter habitat fragmentation. (Benedict & McMahon, 2002, p. 8)

Green infrastructure is comprised of green open spaces and natural areas that link together such as forests, wetlands, parks, greenways, preserved green areas, and native vegetation areas, that naturally operate and help manage a city's stormwater, improve water quality, decrease flood risks, and reduce temperature. Just like all types of other infrastructures, green infrastructure practices need to be executed at many scales in conjunction with grey infrastructure components within the whole interconnected system. Green infrastructure approaches include many levels of planning, from local, neighborhood, town, city, to regional and national, as shown in Table 1 (below).

The techniques are to decentralize the harvesting of surface water run-off, where vegetation can be used to enhance biodiversity and work as a functional space in the urban landscape. These elements of the green infrastructure network must be protected and this requires long-term planning, management and maintenance as an ongoing obligation.

2. Bangkok Today

Bangkok covers an area of 1,568.7 square kilometers (606 square miles), containing 12.390 million people in it. Compared to New York City, with a "2010 population of 8.175 million people distributed over a land area of 790 square kilometers

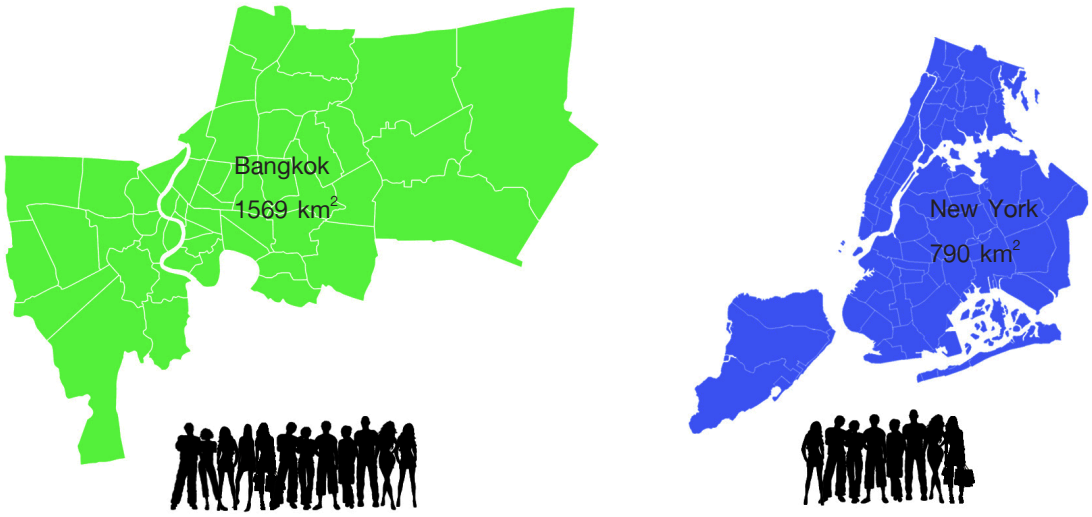


Figure 2. Image shows relationship in scale between Bangkok and New York City.

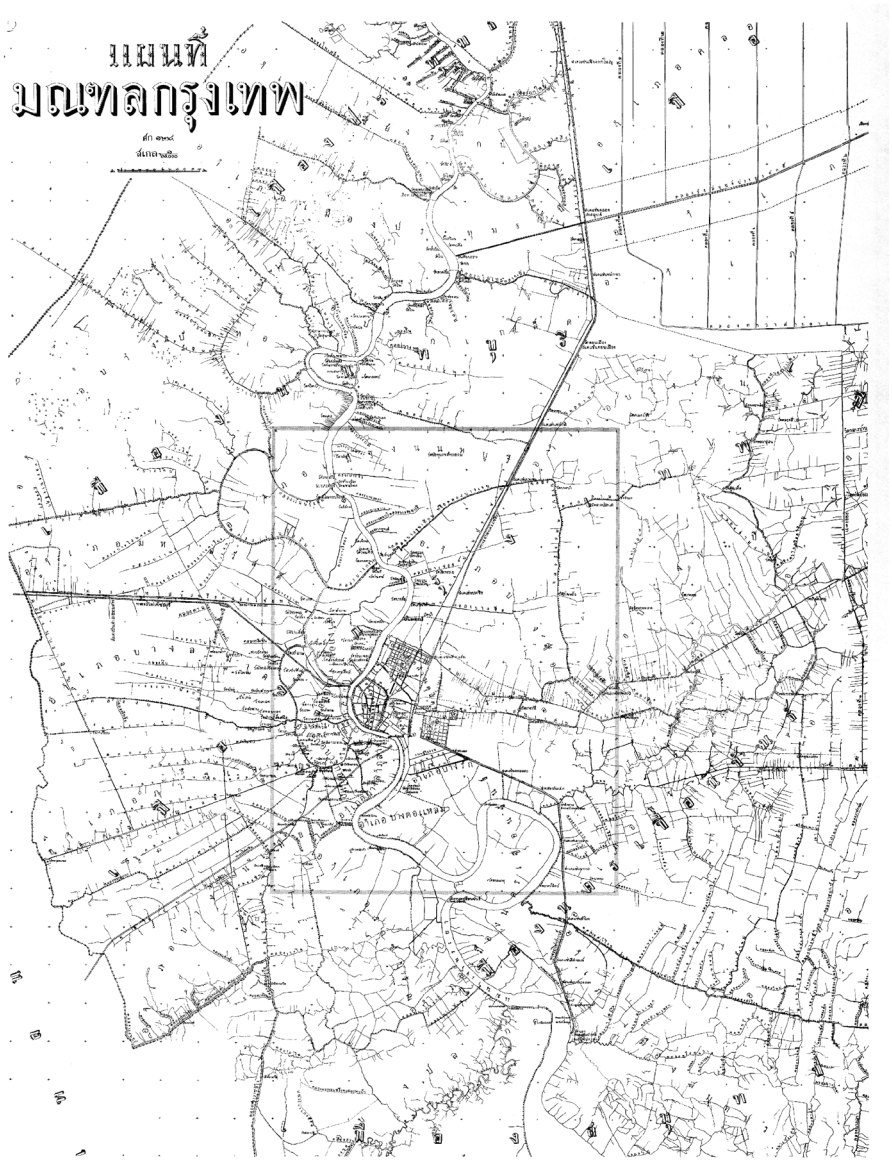
Table 1. Typical green infrastructure and its associated scales.

Typical green Infrastructures and their associated scales		
Local, neighborhood and village scale Town, city and district scale City-region, regional and national scale	**Town, city and district scale**	**City-region, regional and national scale**
Street trees, verges and hedges	Business settings	Regional parks
Green roofs and walls	City/district parks	Rivers and floodplains
Pocket parks	Urban canals	Shoreline
Private gardens	Urban commons	Strategic and long distance trails
Urban plazas	Forest parks	Reservoirs
Town and village greens and commons	Country parks	Forests, woodlands and community forests
	Continuous waterfront	
Pedestrian and cycle routes	Municipal plazas	Road and railway networks
Cemeteries, burial grounds and churchyards	Lakes	Designated greenbelt and strategic gaps
	Major recreational spaces	
Institutional open spaces	Rivers and floodplains	National, regional or local landscape designations canals
Ponds and streams	Brownfield land	
Small woodlands	Community woodlands	National Parks
Play areas	(Former) Mineral extraction sites	Common lands
Local nature reserves	Agricultural land	Open countryside
School grounds	Landfill	Agricultural land
Sports pitches		
Swales, ditches		
Allotments		
Local rights of way		
Vacant and derelict land		

Source: Landscape Institute, 2009, p. 4

(305 square miles)" (City Population, 2010) (Figure 2) our city is about twice the size of New York City. Bangkok has a total area of 2,481.69 rais or 3,970,704 m^2 of public parks, which is equal to 0.70 m^2/ person (Phongspul, 2011). compared to New York City's ratio of 2.5 acres per 1,000 residents, which is equal to 10.12 m^2/ person (Open Space Index, 2008). Our ratio of green space is not even one tenth of New York's, a city with more expensive land values and limited open spaces.

Bangkok has become overcrowded and polluted from its tremendously fast growth. Despite its history of 230 years, we seem to have forgotten the cultural and historic way of living in a city once well-known as the "Venice of the East." A map of Bangkok in 1905 shows the rigid network of "Klongs" and rivers that run through the heart of Bangkok (Figure 3). The rapid growth of the city along the water's edge converted farms and forests to other valuable uses such as ports, industries, and commercial areas, mostly owned by the private sector and done without any land-use plan or existing guidelines. For decades, people have been living along the Chao Phraya River, where the settlements and most agricultural land are located within the Chao Phraya watershed.



Sourse: Royal Thai Survey Department, 1984

Figure 3. Map of Monthon Krungthep 1905.

Early developments along the river occupied most of the riverfront. Our canals have been replaced by roads, and boats have been replaced by all sorts of vehicles that can help us commute much faster. Expansion of streets and roads took up most rights of way, cut down street trees, and barely left any footpaths for pedestrians to walk. The city has been developing so fast without a good plan for the use of its infrastructure as a basic foundation or framework.

Typical infrastructure in a city includes roads, bridges, water supply, sewers, electricity, telecommunication, railways, and so forth. Urban infrastructure systems are much more complex in terms of the many levels of systems–from underneath the ground to up in the air–to facilitate transportation and communication. This is a typical process of city modernization. The more well-organized the infrastructure and the more advanced the technologies, the higher the standard of living and quality of life. The growth associated with modernization and urbanization depends on each city's population and certain socioeconomic values. The green spaces in many major cities, including Bangkok's, have rapidly shrunk over time and are finally disappearing. This has significantly changed our cities' microclimate

and led to an ecologically unhealthy environment. The disappearance of green space has developed and transformed the city's metropolitan area, resulting in the replacement of trees and green space where formerly water could be kept and absorbed. Rapidly urbanized countries terribly abuse the use of land, as is especially the case in Bangkok's suburbs, where growth only appears along the street and keeps going further and further, without the development behind the front strip. Agricultural areas of many square kilometers were suburbanized and affected by the development of new homes and private housing communities. Bangkok definitely needs more open green spaces to improve people quality of living, serving not just as recreational spaces but also multi-functional green infrastructure.

3. Bangkok's "Gray Infrastructure"

Merriam-Webster's Dictionary defines infrastructure as

1) the underlying foundation or basic framework (as of a system or organization),

2) the permanent installations required for military purposes,

3) the system of public works of a country, state, or region; also: the resources (as personnel, buildings, or equipment) required for an activity.

Table 2. History of American infrastructure.

Advances in the History of American Infrastructure

Era	Growth Issue	Infrastructure Solution
Mid-Late 1800's	Public Health and Welfare	Sanitation, Hospitals, Parks, Schools
	Communication	Telegraph
	Industrialization	Planned Communities, Company Towns
	Energy	Coal, Oil, Gas, Electricity
	Transportation	Canals, Railways
Early 1900's	Automobiles	Roads
	Food Production (Dust Bowl)	Crop Rotation, Agricultural Practices
	Communication	Radio, Telephone
Mid 1900's	Energy	Hydro & Nuclear Power
	Nuisances	Community Zoning and Planning
	Pollution	Air/Water/Sewage Treatment
	Transportation	Interstate System, Airports
	Mass Communication	Television
Late 1900's	Garbage	Recycling
	Traffic Congestion	Mass Transit, Alternative Transportation
	Flooding	Stormwater Management, Detention
	Information Management	Computers/Internet
2000+	Sprawl, Globalization	Sound Land Use, Smart Growth
	Sustainability	Green Infrastructure

Source: Williamson, 2003, p. 1

Table 3. History of Thai infrastructure.

History of Thai Infrastructure		
Era	**Growth Issue**	**Infrastructure Solution**
1783-1941	Transportation, boats	Canals system started, total of 95 canals
1864	Automobiles	First Roads
1869	Communication	Telegraph
1871	Education	First School
1884	Energy	Electricity
1886	Public Health	Hospitals
1887	Public Transportation	Railways
1897	Public Health	Water Supply
1910	Public Transportation	Public Bus (Nai Lert Bus)
1913	Public Transportation	Airport
1925	Public Health and Welfare	First Public Park
1948	Mass Communication	Television
1954	Communication	Telephone
1955	Communication	Public Radio
1962	Nuisances	Community Zoning and Planning
1975	Sprawl	Town and Country Planning Act
1987	Information Management	Internet
1999	Transportation	Bangkok Mass Transit System (BTS)
2004	Transportation	Bangkok Metro Public Company Limited (MRT)
????	Sustainability	Green Infrastructure

Source: Bangkok Mass Transit Authority, 2008

Basic infrastructures is also called "gray infrastructure" (PlaNYC & DEP, 2010), which is traditional those man-made structures that reflect a burgeoning population concentrated in major metropolitan areas. The ideal of connecting people to other transportation systems is to move them faster within Bangkok's heavily congested areas.

Table 2 summarizes historic infrastructure improvements in America and shows us the evolution during each century in developing grey infrastructure in the country. Table 3 has gathered Thailand's history of grey infrastructure developments during a period of over two centuries. In comparison with Table 2, a capital city like Bangkok is not lagging far behind in the development of its infrastructure. The innovative technological advancements have responded to the needs and desires of society by creating, adapting and remodeling the infrastructure to replace run down systems. Hopefully Bangkok will focus on a future of sustainable development soon.

4. Where's Bangkok's Green Infrastructure?

Uncontrolled urban sprawl–spread over 24 kilometers across the city over the past several decades–has expanded way too far into rural areas. In the 2006 Bangkok Urban Planning and Land

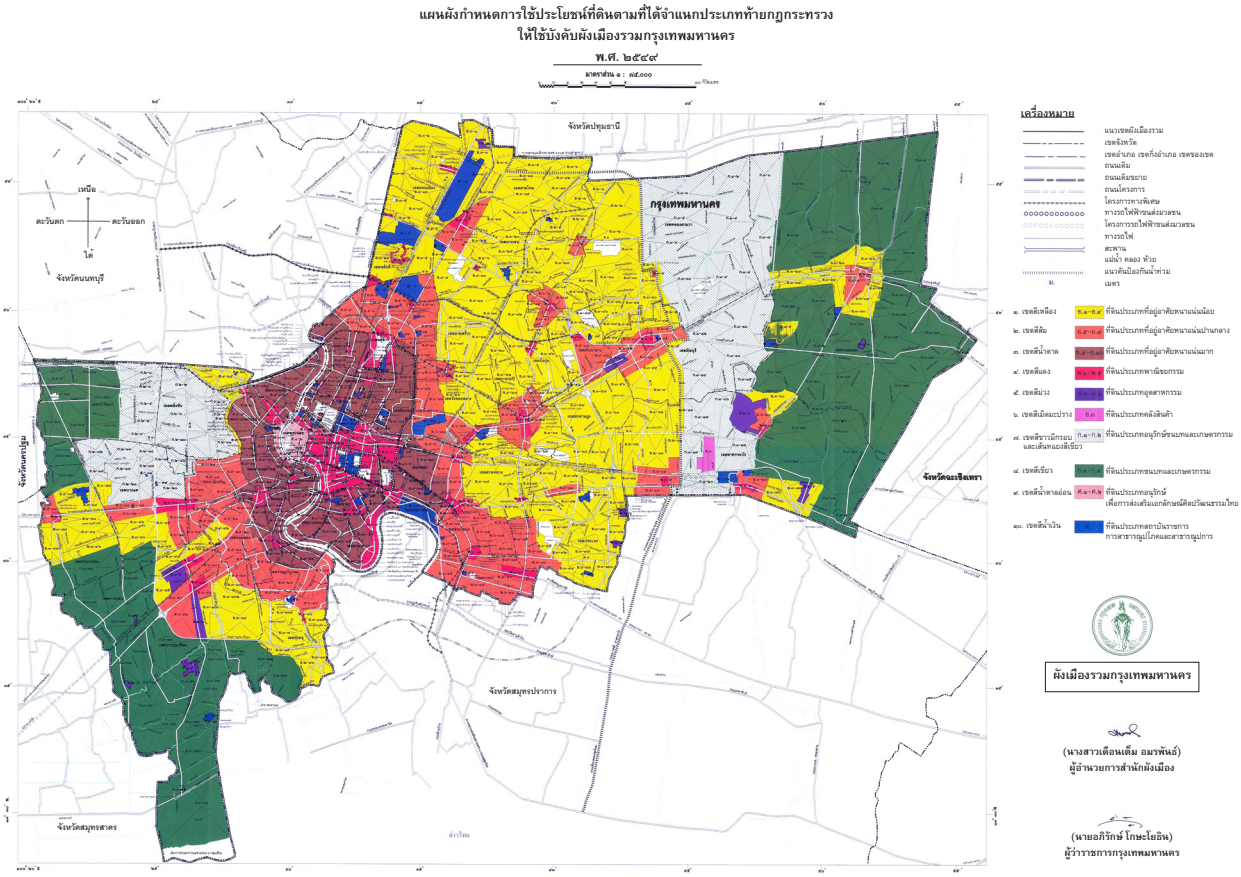


Figure 4. 2006 Bangkok urban planning and land zone map.

Zone Map, the hatched green zone is the rural and agricultural conservation area, the solid green zone is the rural and agricultural area (Figure 4). These two green zones are supposed to be areas for water detention and floodways. The water's edges were once rural, but now they barely have any green space left and no natural edges. Properties along the water edges, where public recreation and multifunctional purposes should be facilitated, are instead owned privately while few public developments have taken place.

When looking at Bangkok's green spaces, it can be seen that the city has scattered green space. Figure 5 has gathered all the green areas of Bangkok together and overlaid them with green areas of rural and agricultural land from the Bangkok Urban Planning and Land Zone Map (Figure 4) to show the proximate locations of these areas. This shows that there is no network connecting these green areas. Rivers and "Klongs" (canals) are forms of natural borders and also linkages, but they are hardly used to connect these green areas. Today, most of the klongs are structural with solid embankments, used only for the city's drainage system. The detention areas as shown are undeveloped and vacant: mostly wetlands and marshlands. The detention areas appeared on the map already included 20 of the 21 "Kaem Lings". The Kaem Ling Project was initiated by His Majesty the King as 21 detention areas all over Bangkok Metropolitan Region. The last one is located right outside of Bangkok. This project seems to be the only functional green infrastructure system in Bangkok. Yet for a city situated only 2 meters above sea level, a high tide is sufficient to flood some of the areas along the river and klongs. Is this system adequate for the whole of Bangkok? The system that we have now is surely not enough, unconnected and unmaintained.

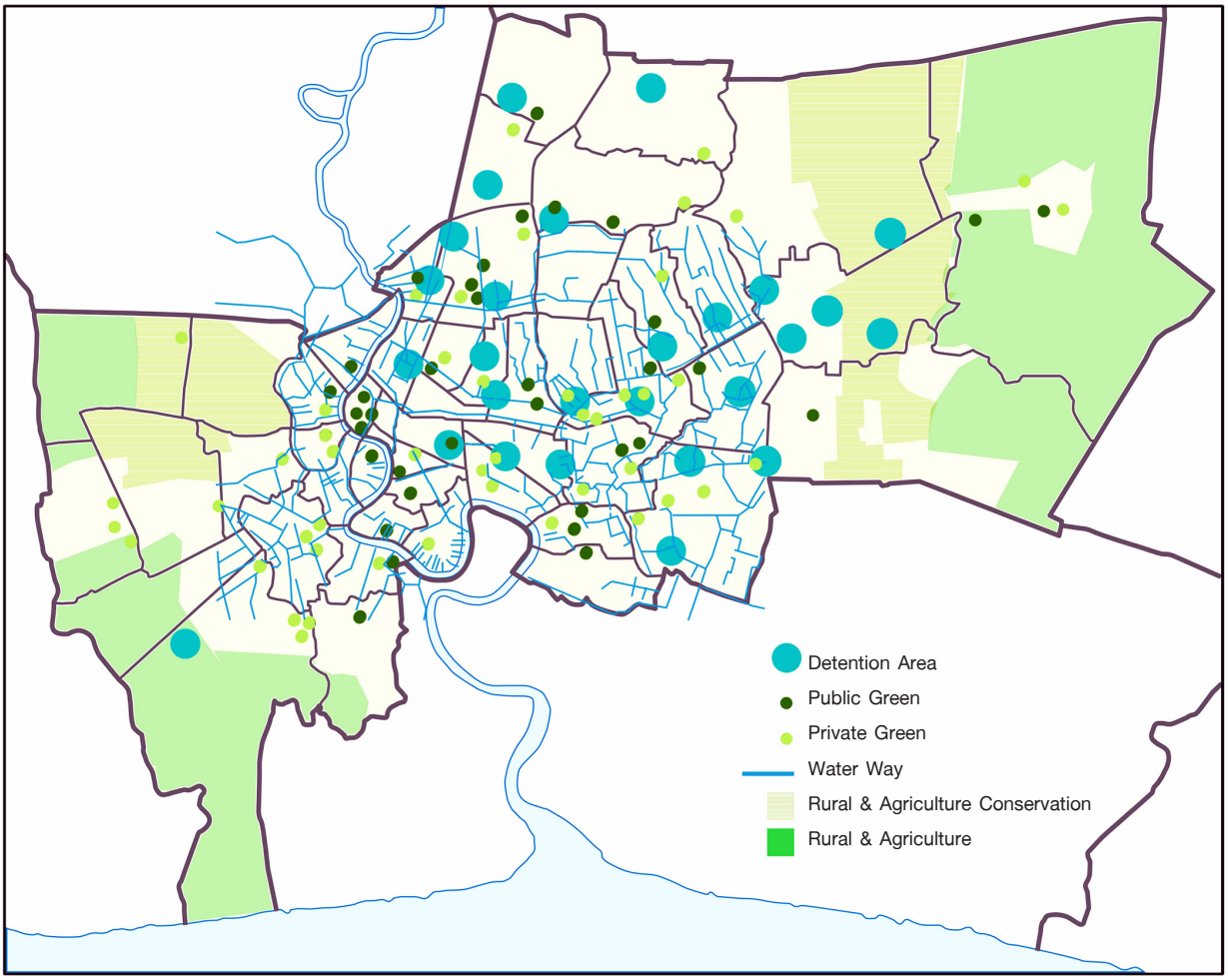


Figure 5. Bangkok's scattered green areas.

Our green spaces are individual standalone spaces scattered throughout the city. The modifications of human developments on the land have created fragmented patterns that threaten indigenous plant and wildlife communities in dispersal to another patches of green area and associated in ecological function and processes such as:

- City's development implies land alteration in response to human needs, which reduces the amount of natural area. Habitat diversity is diminished by the loss of wetland to sprawl, which results in fewer numbers of species and a decline among some of those species that survive.
- Developments have obstructed nature's ability to respond to climate change and population reduction while reducing wildlife genetic diversity and limiting wildlife migration.
- The fragmentation of natural spaces converted into small isolated patches of green spaces, which alters a natural system's function, reduces the number and diversity of natural plants and wildlife, and increases edge habitat.
- Water resource degradation reduces the capacity of flood controls, traps sediments and filters excess unwanted nutrients, while threatening wildlife habitat and plant species that support the environment.

5. Bangkok's Future

With sustainable design approaches, the presumptions of the more information's gather and the future prediction for the city green infrastructure are important. Designing for future, we must interpret as much data as possible to create a deliberate city

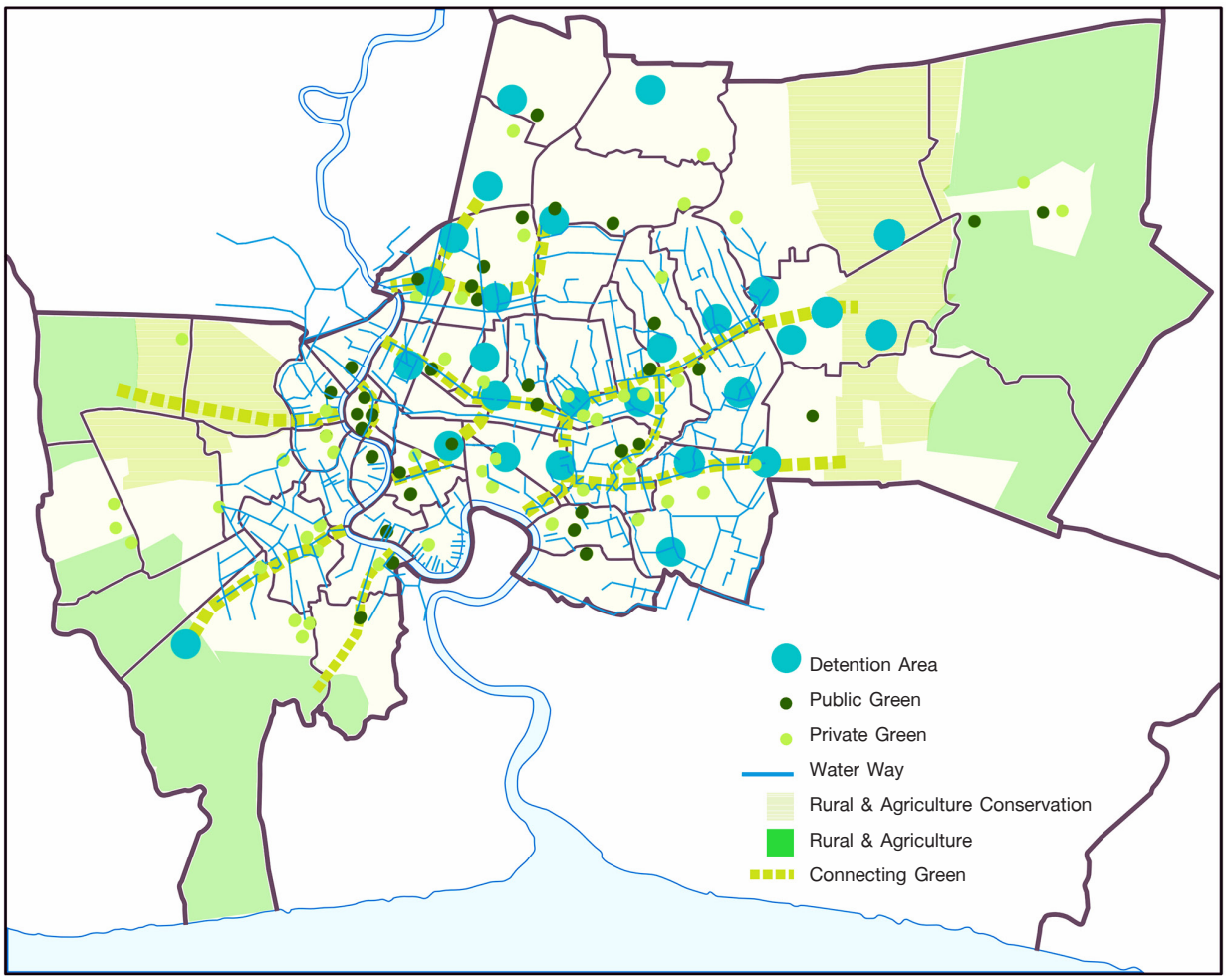


Figure 6. Connecting green network.

plan. Most of us are aware that nothing exists in isolation and that everything is interconnected within some sort of larger system. We cannot propose single-focus solutions to single-focus problems, such as drainage, sewage disposal, or erosion control, but rather develop the management of a whole set of resources (Bangkok Mass Transit Authority, 2008).

Green infrastructure is a perfect solution for Bangkok's water management, especially in the wet season, when rain can occur up to 6 months per year, and extreme rainfalls, massive downpours and thunderstorms are common. Can Bangkok's water features, wetlands, open spaces, and green areas be turned into green infrastructure? To do so, the government should support green infrastructure by enforcing it through laws or regulations for Bangkok. Policy for future development should encourage an increase in the green network or expand the connections between the green areas, while strictly following the Bangkok Urban Planning and Land Zone Map (Figure 6). At the same time, Bangkok's government has to foster community involvement by engaging the residential, commercial, and private sectors in planning, installing, planting, and maintaining the sites.

How do you envision Bangkok in the future? Are we sinking or will the water level have risen? The hatched green zone and solid green zone in the Bangkok Urban Planning and Land Zone Map (Figure 6) show planned floodways that supposedly would prevent Bangkok from flooding, but they are too far out from the heart of the city and the water can come down from the river. There are several old communities living in the floodplain area, but new

housing developments in the flood area can't adjust themselves to accommodate the flood. Building styles and people's way of living have changed, with floods now unacceptable for new developments. People in the communities can no longer adapt to the annual flood.

Interconnecting green space linkages, as proposed in figure 6, will help transfer water from place to place at the regional scale, connecting open spaces and water elements together and decentralizing water detention areas. To be effective at the larger scale, Bangkok must commit to developing green infrastructure with all the available green techniques. The legislation and regulation of green infrastructure represents an agreement between people and the city.

Green spaces in Bangkok can no longer be just for recreation or city beautification. Bangkok's green areas need to become a green infrastructure for the city, with multifunctional uses to serve people's way of living as well as nature, providing a home to urban wildlife. Unconnected green spaces need to be connected and function as a whole system. Interconnecting green areas should be designed with more concern for what the progress of climate change has done to us. The infrastructure improvement of the city needs to be considered by city politicians and agreed upon as a whole to make this an issue of concern in the city's policy, thus enabling for a healthier and more sustainable city to be planned in future. Of course, it is not easy to find enough spaces to create a system in one day or just through a single solution. In the process, expropriation of land might draw popular resistance or protest against the city. Public understanding and risk communication must be an ongoing process from the beginning to the end to ensure the cooperation of the people. Green infrastructure is important to the city, and it is not too late to start thinking about how to design a better city for people to live in and minimize any environmental impact from development. Cities' guideline plans of conservation of green infrastructure should be provided for future planning and to ensure natural resources are preserved for future generations.

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