

A Preliminary Review on Frameworks for Thai Climate Risk and Approaches in Social/Economic Vulnerability Assessment in Bangkok

Prepared by Khanin Hutunuwatr, Ph.D.

“Governance and social justice issues, institutional, jurisdictional and social conflicts, etc. that may worsening climate related issues?”

Issues in integrated framework and inter-institutional and jurisdictional links

For the last five years, literature in the field of disasters indicates the pressing needs for integrating three domains of research and policy communities: climate change adaptation, disaster-risk/ vulnerability reduction, and development (e.g. Mercer, 2010, Label, 2009; Parnell et al., 2007; Schipper and Pelling, 2006). The three domains are highly related but conventionally work separately in many cases (Thomalla et al. 2006). The separation of the three domains may worsen climate-related issues. Institutional linkage is one of the key challenges for such integration.

At the national policy level, there are integrated efforts, but we do not know much at the city level. Climate change is now one of key components of the Thai National Social and Economic Development Plan in which staff from Department of Disaster Prevention and Mitigation serves the committee of the climate change adaptation planning. However, it is unclear to what extent the adaptation plan takes vulnerability perspective into account. It is argued that the field of vulnerability can be significant contribution from disaster research communities to investigate human dimension of climate change (Ford et al. 2010; Helmer and Hilhorst, 2006). The lack of vulnerability perspective in efforts for climate change adaptation may miss the opportunity to address issues at their root causes (Thomalla, et al. 2006).

At the city level, the Bangkok 5-year Action Plan for Climate Change identifies communication among different sectors. This strategy could lay ground for the integrated framework. Other strategies of the plan are involved with development and disaster preparedness, but according to the preliminary reviews, the plan paid little discourse on vulnerability reduction (EEPSEA, 2008; BMA, GLF, and UNEP, 2009).

Despite the above efforts, the issues of inter-institutional links were raised in meetings regarding climate change and planning observed in Bangkok during 2010 by a few agencies, including those under Bangkok Metropolitan Administration. The need for inter-institutional linking mechanism for climatic related planning was identified. This is consistent with the literature indicating that institutional structure is one of the key challenges for the integrated framework (Schipper and Pelling 2006).

For general public, Bangkok may have unique characteristics of collaborating and coordinating culture. Some evidences demonstrate the potential of ad-hoc, urgent, and short-term collective actions regardless of scale such as the city-clean up activities in down town areas after recent political crash. However, it is said that long-term commitment can be critically challenging. This may impact the nature of inter-institutional collaborative efforts. Other factors such as communication culture, perception of collaborative projects, and skills required for teamwork may be additional explanatory attributes.

Interestingly, National Food Insecurity and Vulnerability Information and Mapping System (FIVIMS) Thailand located in Bangkok is able to run the inter-agency network to conduct food insecurity assessment. The network is called The Inter-Agency Working Group on Food Insecurity and Vulnerability Mapping Systems (IAWG-FIVIMS). It can be an interesting model for lessons learned.

“Have social/economic vulnerability to climate related risks have been assessed and/or mapped, how, by whom, details?”

There are studies related to social and economic vulnerability to climate related risk. They vary in frameworks and methods initiated by different agencies as summarized in Table 1.

Table 1. Studies related to social/economic vulnerability to climate risk in Bangkok

	Key assessment concepts	Results	Agencies
FIVIMS, Thailand (FIVIMS Thailand, 2004)	ADDATI software, using 37 indicators such as GNP, household income, food price index, volume of food production, under weight population etc.	Bangkok Metropolitan Region is least vulnerable to food security compared to the whole country while most vulnerable provinces are mostly located in the north-east and the north regions.	FAO, UN National FIVIMS Secretarial Center for Agricultural Information, Office of Agricultural Economics, Ministry of Agriculture and Cooperatives
EEPSEA’s assessment (Anshory Yusuf and Franciso , 2009)	UNIPCC framework Overall vulnerability= f(multiple hazard map*human and ecological sensitivity*adaptive capacity) Human sensitivity= population density Adaptive capacity= socio-economics, technology, and infrastructure Socio-economics= f (Human Index*Poverty Incidence*Income Inequality) Human Index= f (Standard of living*longevity*Education) Weight is assigned by experts’ opinions	Bangkok is : medium-high climate-vulnerability, high multiple climate hazards, high human sensitivity, and high adaptive capacity	EEPSEA
Flood Vulnerability to the rise of sea level (Dutta, 2007)	scenario approach. Impacts= f (loss function* Scenario of inundation) Loss Function= f(Scenario of urbanization* socio-economic database)	The results show in the form of percentage of impact areas regarding to 3 inundation scenarios.	Monash University, Australia

The World Bank Climate Change Impact and Adaptation Study for Bangkok Metropolitan Region Panya Consultant Co. Ltd. 2009)	Unclear methods Most focuses are on physical aspects, but one dimension is on “in-come losses”	Daily wage earners in condensed communities located in low-elevation areas are identified of vulnerable groups for losses of income. Spatial distribution of these vulnerable groups are provided.	Private consultant firm. The World Bank
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EEPSEA’s assessment and FIVIMS applied multi-geographical approach at national and multi-national scales. This approach usually aimed at comparing and ranking level of vulnerability across geographical scale. While flood vulnerability assessment is conducted at the city scale, it seems to aim at identifying threshold and spatial impacts.

According to Eakin and Luer (2006)’s classification of vulnerability assessment of socio-environmental systems, it appears that most assessments of Bangkok’s vulnerability applied mapping, ranking and comparing vulnerability approach relying on quantifiable indicators. This approach tended to treat vulnerability as attributes rather than underlying social process. Objectivity and availability of database of these measures are among key preferences of this approach. Challenges in this approach are the lack of process dimension, limitation from relying on available database, comprehensiveness of indicators, subjectivity in indicators selected, and the rigidity of weight assignment, and insensitivity to context-base vulnerability (Hutanuwatr, 2009;Eakin and Luer, 2006; Turner et al. 2003). It is not surprising that in Economic and Social Survey of Asia and the Pacific 2008, for example, United Nations vulnerability index are subjected for improvement such as the inclusion of wars and political unrest into its framework (UNESCAP, 2008).

While there are only a few vulnerability studies on process-oriented, qualitative and place-based approach (if any), studies on marginal groups such as informal sectors or slum dwellers in Bangkok (e.g. Nirathron, 2009) can inform vulnerability studies in this approach. However, the link to climate-related risk is needed.

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Gender Perspective on Climate Change Risk and Vulnerability

Prepared by Jummai O. Yila

“Have social/economic vulnerability to climate related risks have been assessed and/or mapped, how, by whom, details?”

A variety of technical studies have been undertaken that outline likely impact scenarios, (ONEP, 2008; World Bank, 2008; World Bank, 2007; World Bank, 2008b; World Bank, 2006; Institute of Development Studies, 2007; Greenpeace, 2006; BMA, 2007). The main potential impacts and vulnerability identified in these studies are:

(i) Mean temperature increase 3-3.5% by 2100 about one million people will be affected by a 30 year flood in 2050. Of these, one-third (330,000) will be affected by half meter flooding for at least a week.

(ii) Buildings will be the most affected structures. More than one million buildings might be damaged by such a flood, causing over \$3 billion USD damage (2008 prices).

(iii) Water supply, sanitation, public health, energy, and transportation infrastructure will be minimally affected. This is both because much key infrastructure is in protected areas (the core city), and many systems, particularly those built since the 1995 flood, are designed to withstand significant flooding. For example, MRTA subway stations are raised and the new Suvarnabhumi International Airport international airport, despite being on land that was below sea level twenty years ago, was constructed on land fill raising its elevation several meters.

(iv) There would likely be significant increases in diseases and accidents associated with flooding and temperature rise, of special concern is dengue fever, but other risks include salmonellosis, electrocution, drowning, etc.

Knowledge status and research gaps:

Exposure unit Places, sectors, activities, Individuals, households, social groups, communities, livelihoods are not factored in these assessment

“Current perception of climate change related risk (such as floods, water and food supply, land losses, air quality, heat stress, disease outbreaks, etc.) and social/economic vulnerability (such as poverty, investment, capital and opportunity losses, social conflicts and divides, genders, justice, etc.) in your city, e.g., how do they perceive on the differences and linkages between weather/climate risks and social/economic vulnerability?”

- *Among general public*
- *Among urban officials, city managers*

As per the current perception of climate change and related risk, it seems there has been an over emphasis on flood related risk than any other both among the general public and the urban officials/city managers. Among the general public however, especially within natural resource dependence communities, flood is perceived as part of the natural cycle

where tolerance and acceptance level is very high, hence shaping behavior and coping strategies

For gender and justice issues, most vulnerability assessment focused mainly on physical and/climatic aspects of vulnerability, little attention or studies give consideration to the non climate factors that exacerbate individual or household vulnerability which if ignored in city planning would render successful planning or policy problematic.

Secondly, Bangkok/Thailand national assessment did not capture the influence of processes operating on all these scales. There is an inevitable tension as vulnerability is best defined at a point, at a particular location in space or within the community, and any aggregation to the national level can result in a loss of information, for example how people and places are affected differently, what explains differential capacities to cope and adapt and the causes and consequences of differential susceptibility?

Therefore vulnerability is moderated by existing inequities in resource distribution and access, the control individuals can exert over choices and opportunities, and historical patterns of social domination and marginalization

Climate Change and Migration

Prepared by Albert Salamanca, PhD

Among the issues related to the social impacts of climate change, migration and other forms of mobilities are the some of the least understood and discussed. Bangkok's economy has, for a long time, been dependent on labour sourced out from the countryside. The industries located in coastal provinces Chonburi, Samut Prakarn, and Samut Sakorn, which are also vulnerable places to the impacts of climate change, rely heavily on labour supply coming from adjacent provinces and the northeast. Through remittances, the economic well-being of these provinces has been sustained. Any disruption, therefore, on the demand of labour and a reduction in income possibly through the closure of factories, decline in profit and transfer of industrial production elsewhere will have material impacts on the households dependent on these remittances.

Another aspect wherein coastal urban areas may be affected by climate-induced vulnerabilities is through the movement of people displaced from provinces where farming productivity declines due to weather disturbances such as prolong drought. These people in search of a better income will seek opportunities in the city thereby increasing the ranks of the unemployed and burdening social services. Moreover, the impact of climate change on workers who commute daily to work in these provinces need to be assessed. The severity of extreme weather events driven by climate change may affect their pattern of work and living when transport infrastructures are disrupted. This will have costly implications also to companies who rely on this labour as work stoppages due to absence will affect their productivity.

On a related matter, some of the attractions for companies to locate in the Eastern Seaboard are the benefits expatriate staff receive in terms of proximity to international schools for their kids, hospitals, entertainment venues, restaurants, and other business support services, to name a few. Such proximity is underpinned by mobility. That is, the ability to reach these places within a reasonable duration. Climate-induced variability can potentially alter the attractiveness of the BMR for international companies to base their operation here by limiting access to these services. Roads may be blocked due to flooding or congestion will become an everyday reality.

We, therefore, need to understand how urban and rural areas are linked by migration and the 'tipping-point' with which migration due to climate-induced variability is activated as a livelihood strategy. We also need to understand how other forms of mobilities may be affected. We need to ask what lessons can we learn from existing anticipatory, autonomous, and planned adaptation mechanisms to adjust to extant natural hazards in coastal urban regions in the BMR. Given these lessons, how do we infer future adaptation mechanisms to the increasing severity, frequency and exposure to natural hazards caused by climate change.

Urban Development Perspective on Climate Change Risk and Vulnerability: Landscape Urbanism, Landuse Plan and Informality Economy and Settlement

Prepared By Wijitbusaba Ann Marome, PhD, Asan Suwanarit, Rachaniporn Tiampayothorn, Torwong Chenvidyakarn, PhD

“Have various climate risks to your city have been assessed and/or mapped, and if so do they take into account possible effects of current and future climate changes?”

Climate change related risk	Assessment	Mapped	Agency and Institution
1. Floods	<p><u>Rain water</u></p> <p>Faced with seasonal monsoon rains and daily tidal fluctuations, greater Bangkok now faces the threat of catastrophic flooding each year. From May to October the combination of elevated river flow from the Chao Phraya basin and rapid local runoff often puts many sections of the city and its environs under water. And when a high tide slows the flow of the river, it is impossible to drain the city without the help of floodwalls and pumping stations. <u>River flow, tidal surge, and sudden torrential rain</u> have prompted some to refer to Bangkok as “the city of three waters.” (i)</p> <p><u>Rising seawater + Land subsidence</u></p> <p>The city also suffers from land subsidence, caused by over-pumping of groundwater and the thick soft clay on which the city is built. Each year, parts of the city sink by 5-10 mm and by as much as 30 mm in outlying southeastern and southwestern areas. This subsidence, when combined with a rising sea level could leave Bangkok under 50-100cm of water by 2025. (ii)</p>	<p>Statistic: Meteorological data of Bangkok metropolis</p> <p>Map: Land subsidence rate of Bangkok in 2002 (a) and in 1981 by Phien-wej et al., 2006. (iv)</p>	<p>Dept. of Meteorological</p>

	<p>The simulated outcomes of the flood model used in the study indicate that almost 55 per cent of Bangkok would be affected by floods if the mean sea level were to rise by 50cm, and 72 per cent of the city would be affected if the mean sea level were to rise by 100cm. (iv)</p> <p>The maximum subsidence is now occurring in outlying areas of Bangkok in the southeastern and southwestern industrial zones, where the phenomenon is taking place at the alarming rate of 30 mm per year. Land subsidence not only causes damage directly, but it also intensifies the impacts of flooding while threatening human life and property. In the Chao Phraya River delta, the risk factors are greater than in most other coastal cities due to land subsidence. (iv)</p> <p>The shortened time lag from a torrential rainfall to flooding is a result of the increased number of impermeable areas in this catchment basin. A concentration of flood flow waters and the transmission of the peak of flood discharge has been accelerated and aggravated flood disaster. (V)</p> <p>Inundation damage is also caused by local rainfall in the plain. Man-made structures, such as roads, dikes and irrigation equipments prevent in the lower plain from draining away. These conditions account for increase in flood-prone areas. (V)</p>		
<p>2. Water supply</p>	<p>Most of Bangkok's water supply (91%) comes from the Chao Phraya and Mae Klong rivers. <u>Climate change will affect the flow of waters</u> in the two rivers, affecting the city's water supply. Increasing demand for water as temperatures rise, from households and industries may further exacerbate this projected change in water supply. Since Bangkok is expected to continue to grow over the next 10 years, the problems of</p>		

	<p>water supply and contamination of both surface and ground waters may worsen. (ii)</p> <p>The Metropolitan Waterworks Authority (MWA) supplies about 4.65 million cubic metres (Mm³) of purified water per day to residential, industrial and commercial users in Bangkok, using surface water withdrawn from the Chao Phraya and Mae Klong rivers. This represents 91 per cent of the city's total demand (BMA, 2006); the remaining 9 per cent (about 0.5 Mm³/day) is met by extraction of water from deep wells (Polprasert C., 2007). (iv)</p> <p>The effects of global warming have caused the river flows in Thailand to be unreliable, with too high or too low flow rates during the rainy and dry seasons, respectively. Increasing demand may further exacerbate the projected changes in water supply. (iv)</p>		
<p>3. Heat island</p>	<p>The change in land use effects to Bangkok's temperature to be higher than the suburb by 2°C. From 1956 –1997 the Bangkok's lowest temperature increased by 2°C. (iii)</p> <p>Bangkok and its suburbs are already experiencing more severe and frequent flooding and more days with temperatures above 30°C. (ii)</p> <p>A study by the Department of Meteorology on the variations in maximum and minimum temperatures in Bangkok during the previous 10 years, compared with long-term averages, found that from 1991 to 2000 the maximum average temperature in the summer months was significantly higher than the long-term average. Conversely, the lowest temperatures in the winter months were warmer than the long-term average (Department of Meteorology, 2008). (iv)</p>	<p>Statistic: Meteorological data of Bangkok metropolis</p>	<p>Dept. of Meteorological</p>

	<p>Figure 2.2 clearly illustrates that the observed annual mean temperatures in Thailand between 1981 and 2007 are increasing. Overall, the temperature rises demonstrate an upward trend during the same period. Annual mean minimum and maximum temperatures from 1951 to 2005 are shown in figures 2.3 and 2.4, which also show a rising trend. (iv)</p> <p>In urban Bangkok, the number of days exceeding 35 °C is rising (see figure 2.9). The impacts of climate change on Bangkok have thus become increasingly visible and have been the subject of serious concern among residents since 1967, as they experience increasingly hotter weather (Department of Meteorology, 2008). (iv)</p>	<p>Statistic: Meteorological data of Bangkok metropolis, 2008.</p> <p>Statistic: Meteorological data of Bangkok metropolis</p>	<p>Dept. of Meteorological</p> <p>Dept. of Meteorological</p>
4. High salinity in river			
5. Coastal erosion	<p>Thailand's long coastline (a total of 2,615 km) makes it especially vulnerable to the effects of climate change. In this regard, the country's capital and major port are especially at risk. A recent study ranking the cities of the world most exposed to coastal flooding today and in the future provide interesting insights into this vulnerability (OECD, 2007). The analysis indicates that by the 2070s almost all (90 per cent) of the total asset exposure of large port cities will be concentrated in only eight countries, one of which is Thailand (see figure 1.2). Thailand ranks sixth in terms of the severity of the projected effects. (iv)</p>		

Initiative/ Plan for mitigation

1. Such policy dimensions are being integrated into the country's economic and social development plans. The first to undergo this process was the Seventh National Economic and Social Development Plan, covering the period 1992-1996 (MOSTE, 2000). These principles have also been incorporated into Thailand's environmental policies and plans. Currently, the Office of Natural Resources and Environmental Policy and Planning, under the Ministry of Natural Resources and Environment, is in the process of drafting a strategy to address climate change issues as they relate to Thailand. The strategy will outline the mechanisms and measures that will have to be undertaken by various agencies of the Government. Such measures will include those for reducing greenhouse gas emissions and enabling the country to adapt to the adverse impacts of climate change. These measures will be in addition to those incorporated within the country's five-year plans. (iv)
2. The Bangkok Declaration on the Cooperation of Alleviating the Global Warming. 36 Organizations jointly signed the Bangkok Declaration on the Cooperation of Alleviating the Global Warming on 9 May 2007 at the United Nations Conference Centre, Bangkok. (iii)
3. The Bangkok Metropolitan Administration has adopted the Action Plan on Global Warming Mitigation 2007-2012, which calls for it to: expand mass transit and improve traffic systems; promote the use of renewable energy; improve electricity consumption efficiency; improve solid waste management and wastewater treatment efficiency; and expand park areas. The Action Plan is aimed at bringing about a reduction in Bangkok's greenhouse gas emissions over a period of five years that will be 15 percent below the levels currently projected for 2012. (iv)

Initiative/ Plan for adaptation

1. According to the report, approximately 900,000 people in Bangkok are currently at risk from flood events, and that number would increase to more than 5 million by 2070. The economic losses to the infrastructure that would be caused by such floods is estimated to be \$39 billion currently, but are expected to grow to a staggering \$1.1 trillion by 2070 (OECD, 2007). Although flood protection projects were established and improved after the two previous devastating flood events (Bangkok Metropolitan Administration, 2004), Bangkok is still at increasing risk of flooding, due partly to the effects of global warming and partly to rapid urban development. (iv)
2. The main flood barriers for Bangkok are dykes and walls built along the Chao Phraya River. However, land subsidence negates the efficiency of the city's flood defenses because the high-point of the dykes gradually sinks as the ground beneath these defenses subsides. Land subsidence also dramatically affects the efficiency of the sewer system and underground pipes built to rapidly eliminate rainwater, a situation which tends to aggravate the flooding of urban areas during the monsoon season and periods of very high tides. Further, it makes more difficult the process of draining the low lying areas of the city that are sinking, leading to the formation of stagnant water after flooding. (iv)

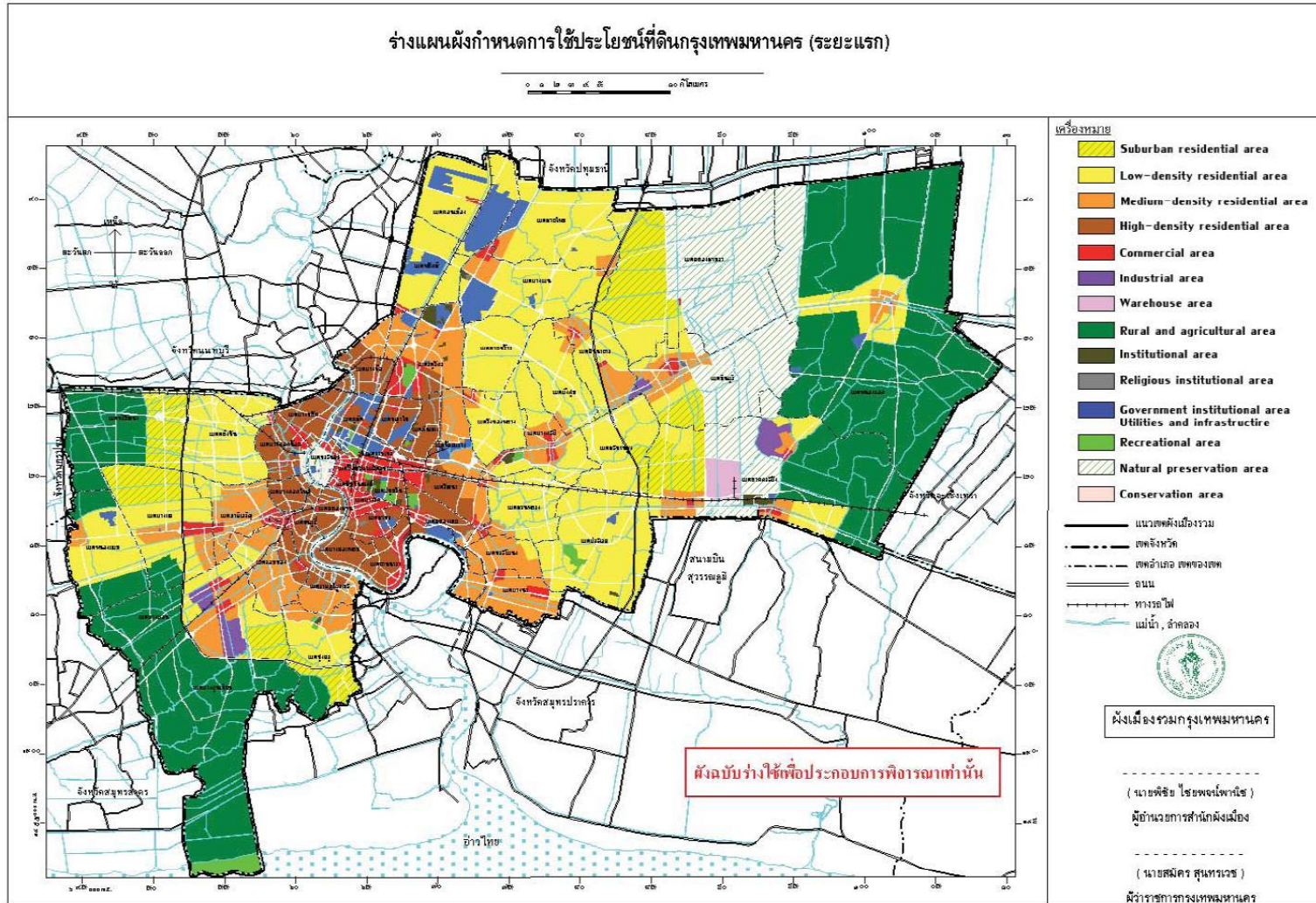
3. Since Bangkok is expected to continue to grow over the next 10 years, the problems of water supply and contamination of both surface and ground waters will also be exacerbated. By the end of the current century, increasing temperatures are expected to boost the demand for water for agricultural purposes between 2 and 13 times in the lower and medium warming ranges, respectively, as well as the demand for water for household purposes (California Environmental Protection Agency). Some options that could be considered if Bangkok is to achieve a sustainable supply of water might include: the harvesting of rainwater, decentralizing the wastewater management system, increasing stakeholder participation and raising awareness among consumers about water issues (Polprasert C, 2007). (iv)

Notes:

- i. Brian McGrath and Danai Thaitakoo, “Changing Landscape, Changing Climate: Bangkok and the Chao Phraya River Delta,” in Place.
- ii. UNEP, Regional Office for Asia and the Pacific.
- iii. Porntep Techapaibul, Deputy Governor of Bangkok, Climate Change Mitigation in Bangkok, September 25, 2009
- iv. UNEP, Bangkok Assessment Report 2009.
- v. Shigeo Haruyama, Geomorphology of the central plain of Thailand and its relationship with recent flood conditions, GEO Journal, Springer Netherlands

“Is there an existing urban GIS information base that may be used for climate risk and vulnerability assessment? What is included?”
“Is there an urban master plan? When it was completed? Does urban master plan take into account future risk to climate change?”

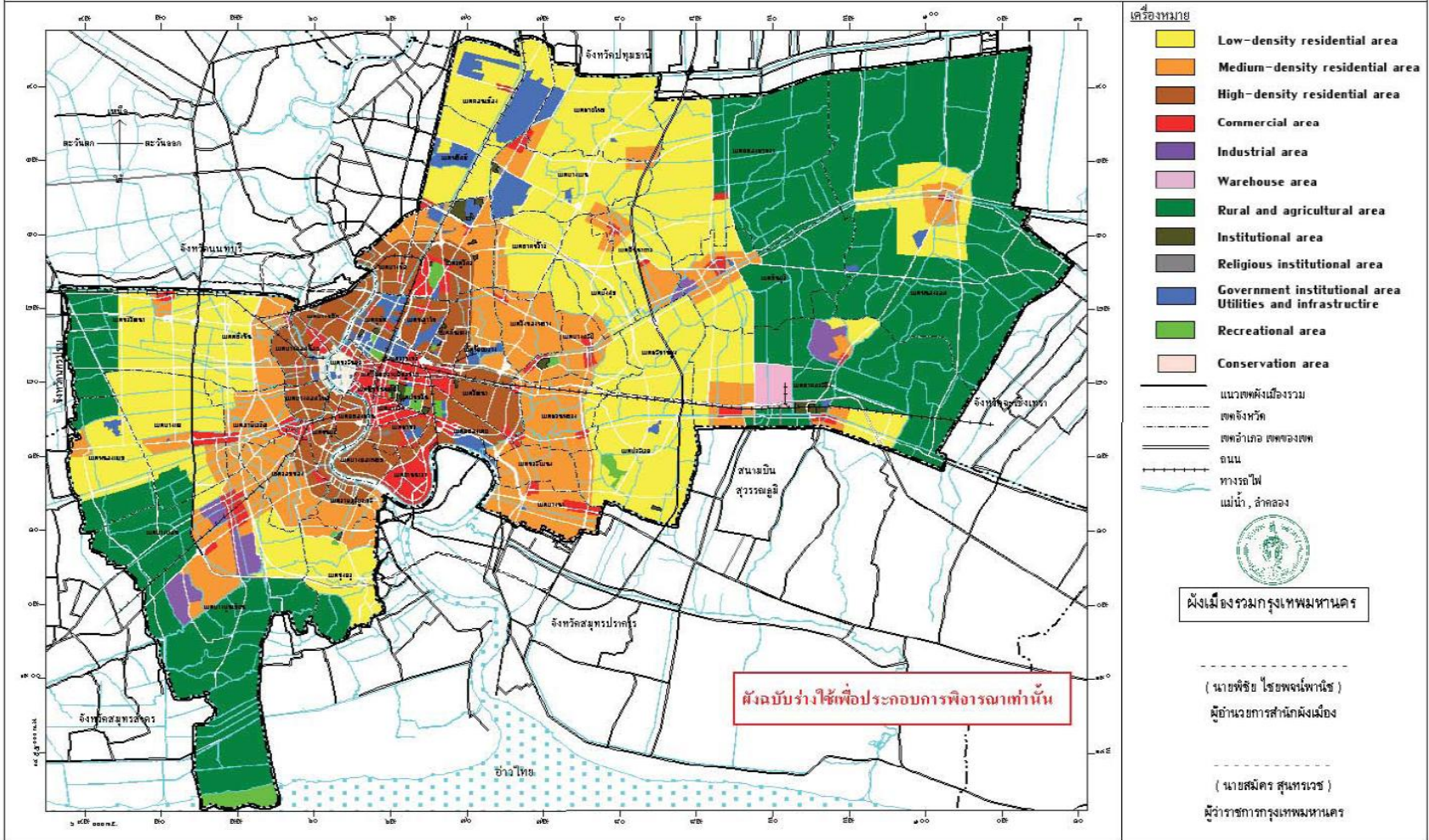
A Preliminary Review on Bangkok Master Plan (2nd revision) and its Climate Related Factor



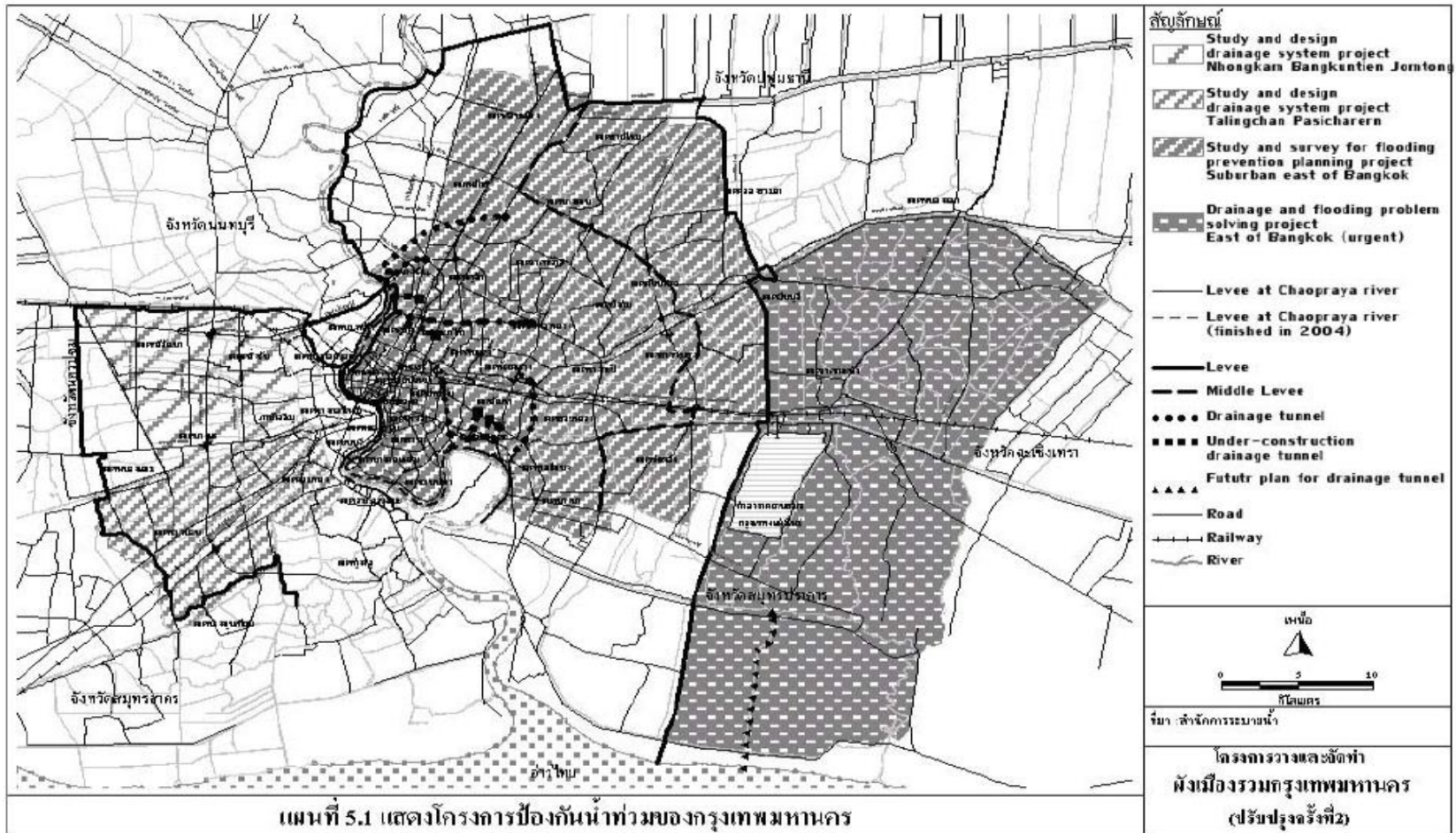
Bangkok Comprehensive Plan (first phase)

ร่างแผนผังการใช้ประโยชน์ที่ดินกรุงเทพมหานคร พ.ศ. 2565

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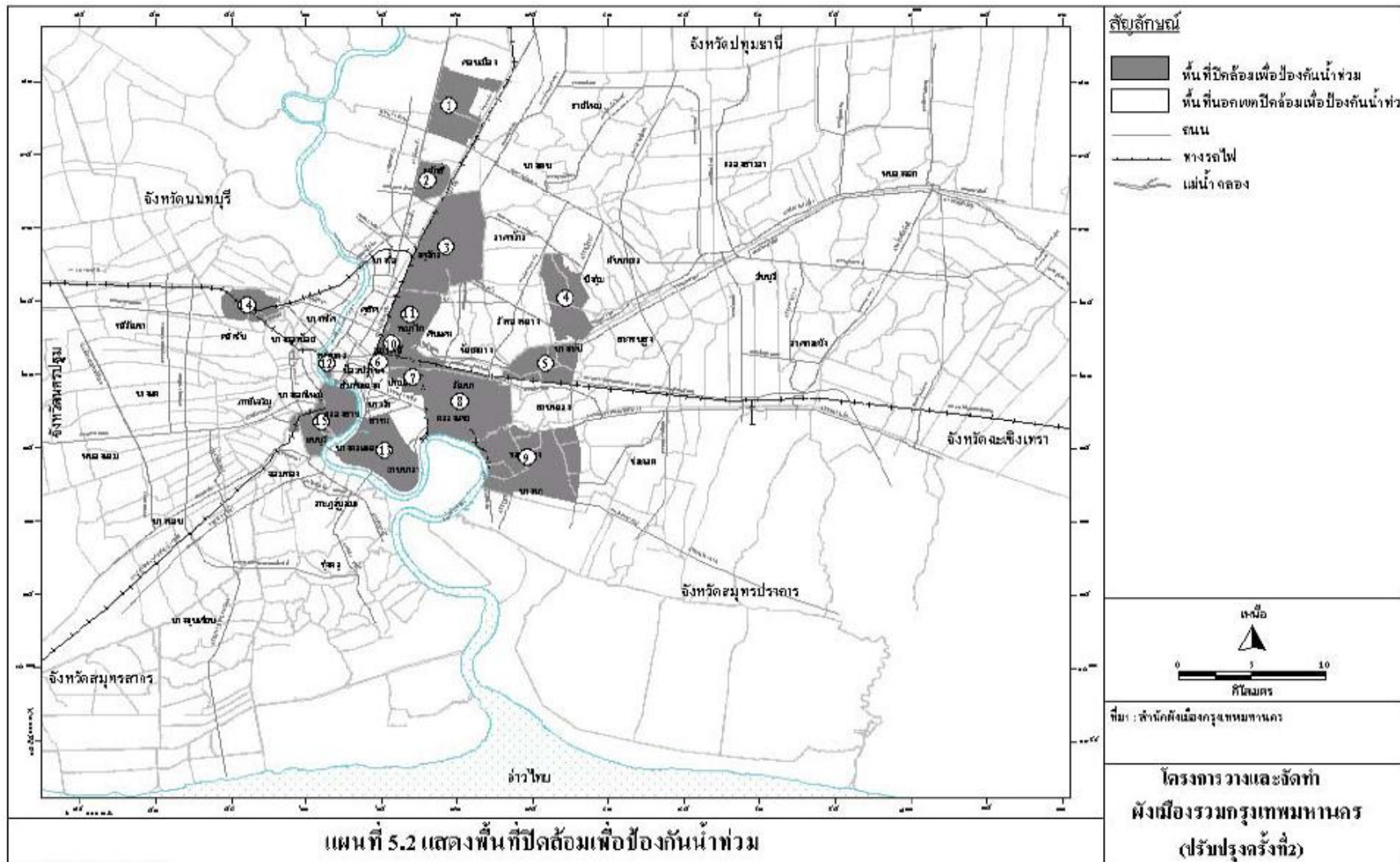


Bangkok Comprehensive Plan in 2022



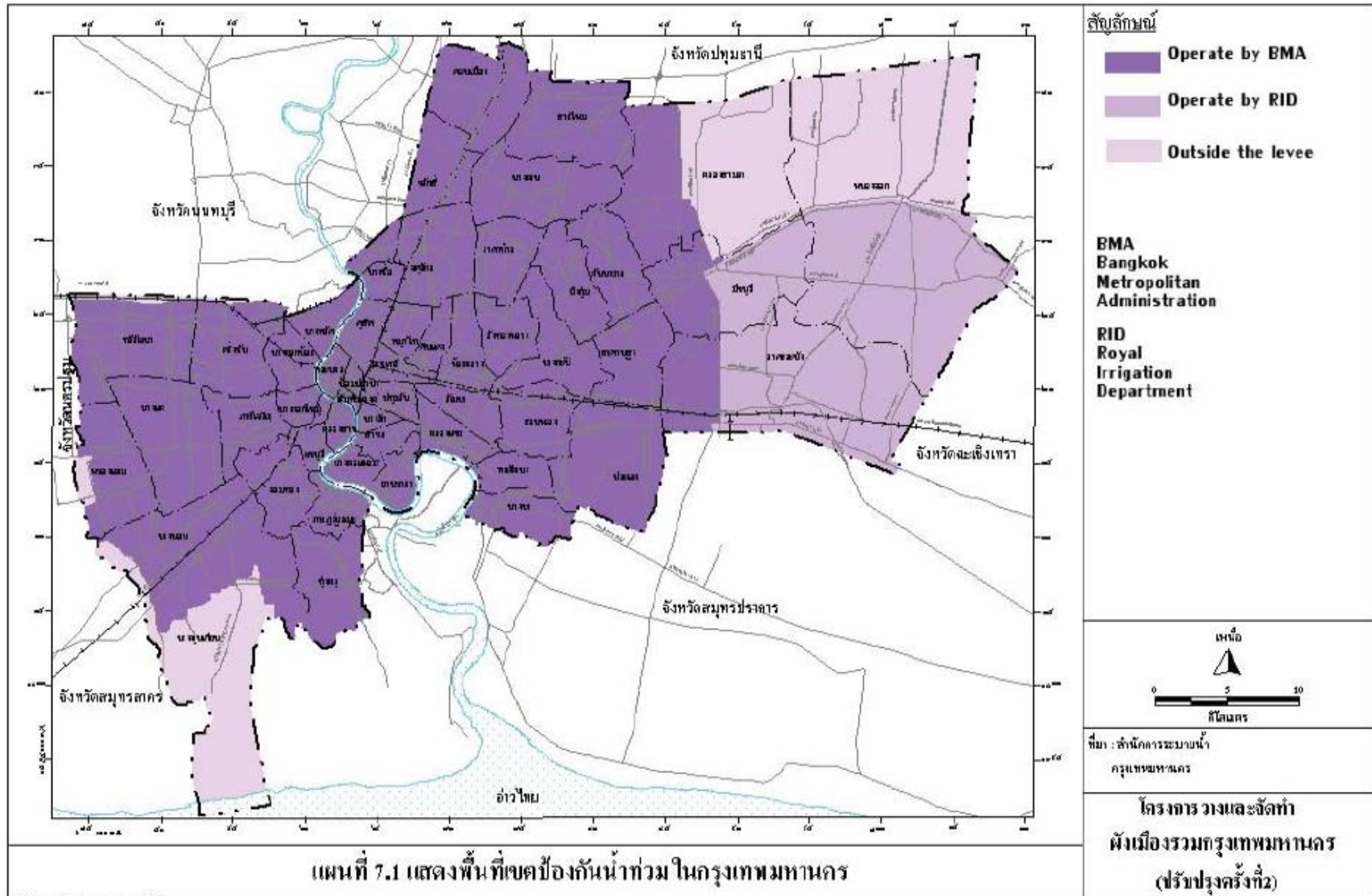
บริษัท กรุงเทพมหานคร จำกัด

Map of Flooding prevention projects for Bangkok



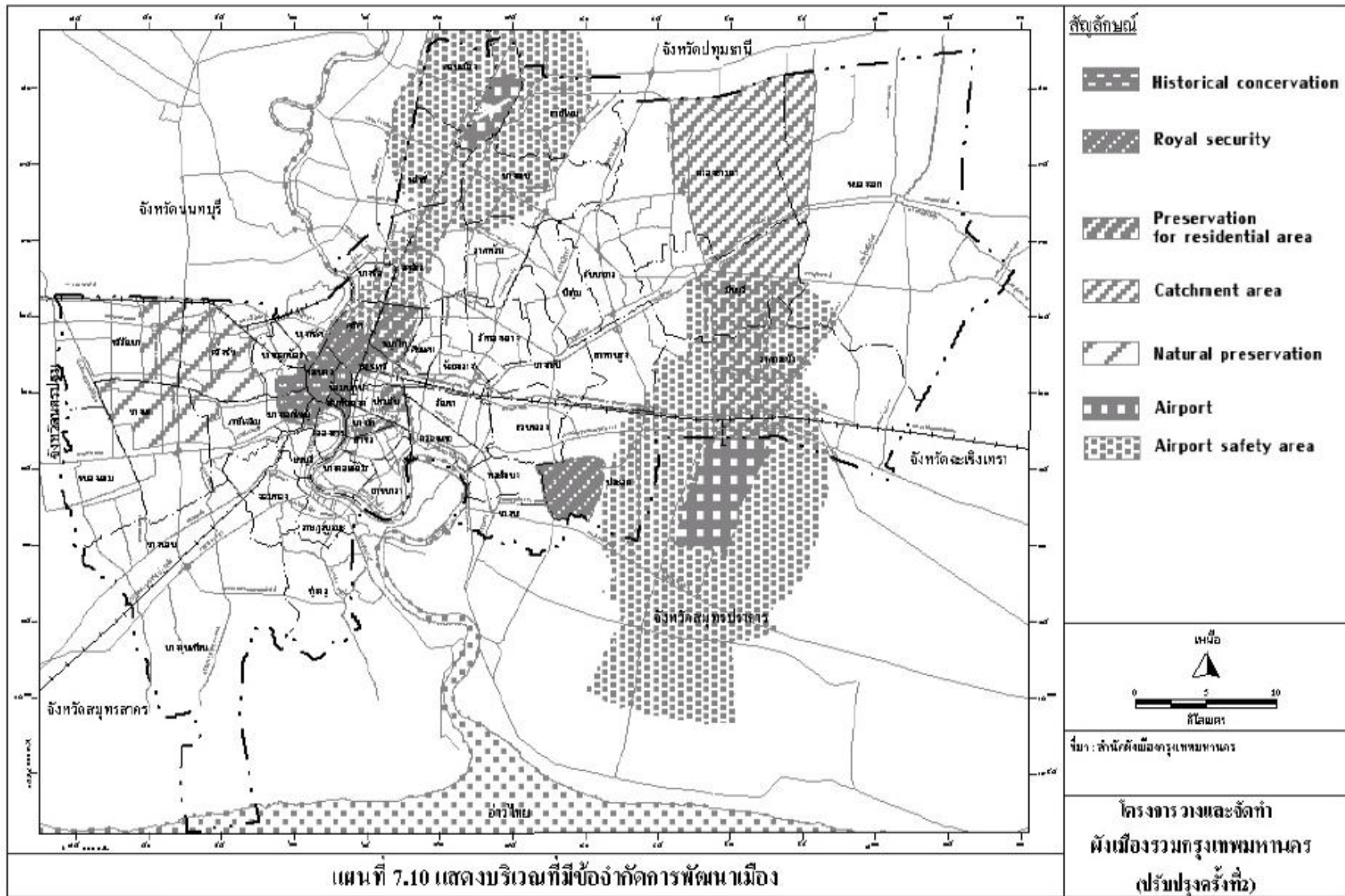
บริษัท กรุงเทพธนาคม จำกัด

Map of Enclosure area for flooding prevention



บริษัท กรุงเทพมหานคร จำกัด

Map of flooding prevention area in Bangkok

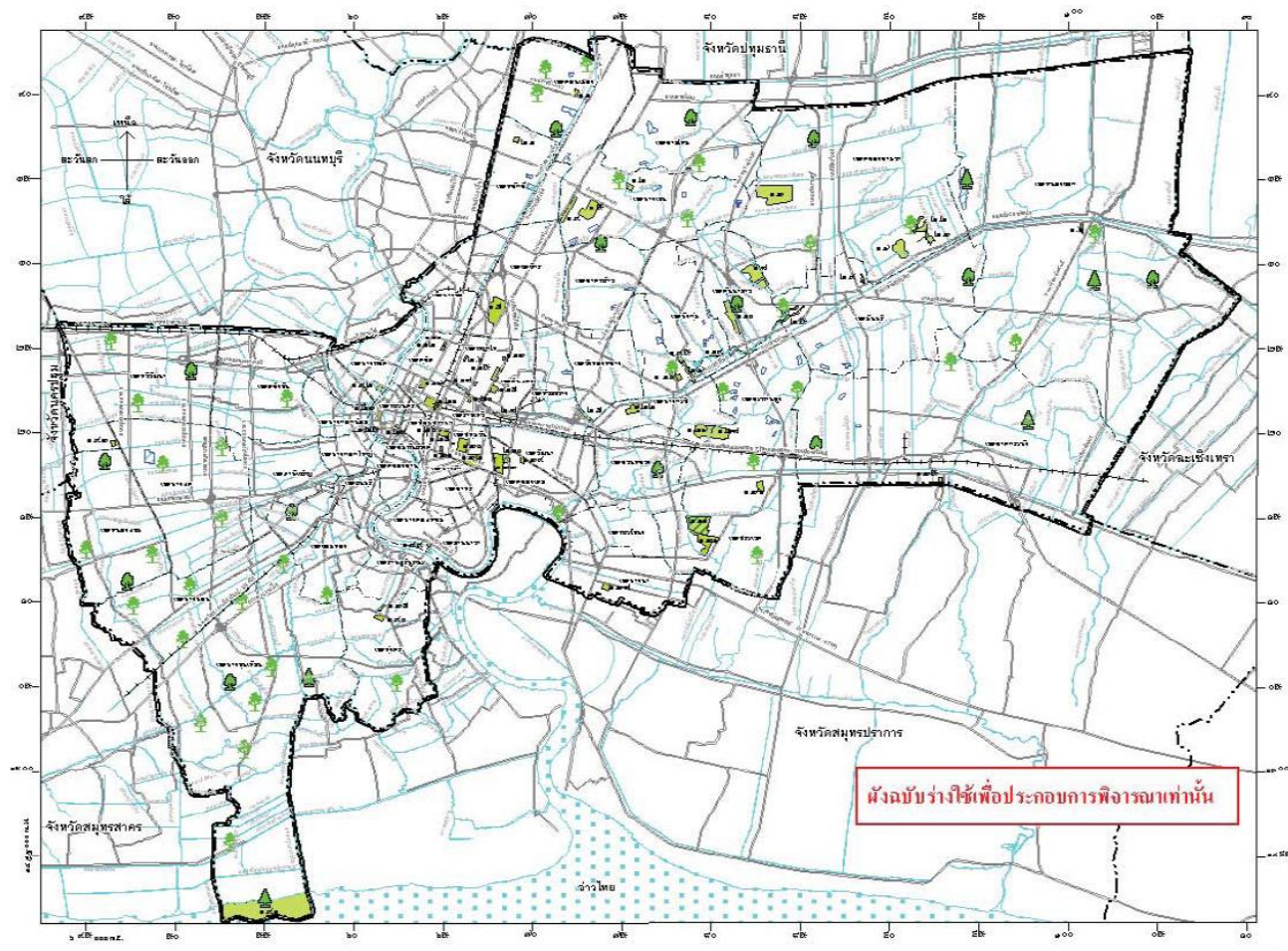


บริษัท กรุงเทพมหานคร จำกัด

Map of restriction in urban development area

ร่างแผนผังแสดงที่โล่งทำยกกระทรง
ฉบับที่ .. (พ.ศ.)
ออกตามความในพระราชบัญญัติการผังเมือง พ.ศ. ๒๕๖๘

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เครื่องหมาย

- Recreation area
- Catchment area
- Suggestion City park (300 rai)
- Suggestion District park (100 rai)
- Suggestion Community park (50 rai)

- แนวเขตผังเมืองรวม
- - - - - เขตจังหวัด
- - - - - เขตอำเภอ เขตของเขต
- ทางหลวง ถนน
- ทางรถไฟ
- แม่น้ำ ลำคลอง
- ที่ลุ่ม บึงหนองน้ำ สระน้ำ



ผังเมืองรวมกรุงเทพมหานคร

(นายพิชัย ไร่พงษ์ไพเราะ)
ผู้อำนวยการสำนักผังเมือง

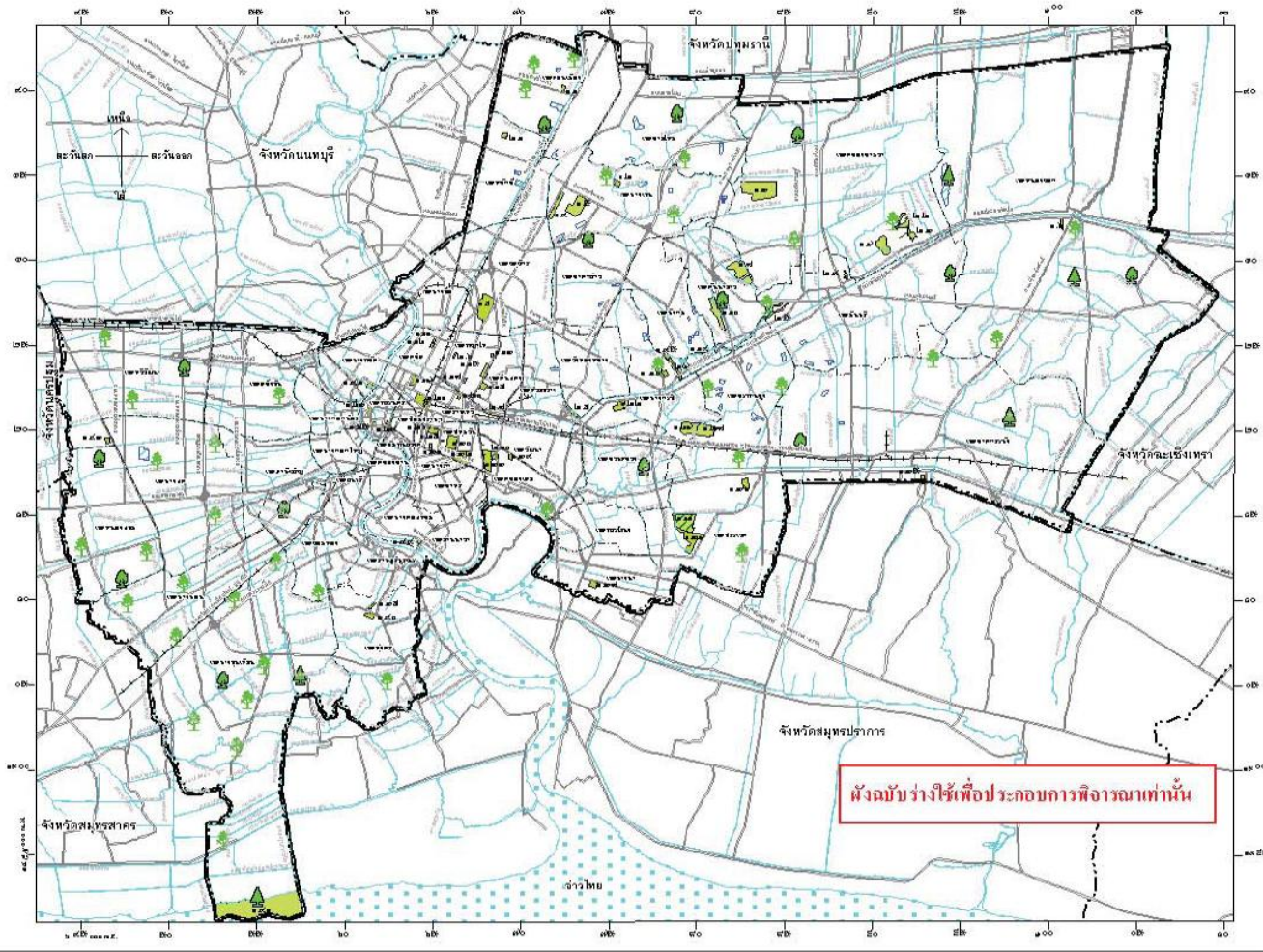
(นายสมิตรี สุรินทร์เวช)
ผู้ว่าราชการกรุงเทพมหานคร

ผังฉบับร่างใช้เพื่อประกอบการพิจารณาเท่านั้น

Map of Open space in Bangkok (draft version)

ร่างแผนผังแสดงที่โล่งทำกิจกรรมทาง
 รมบี้ที่ .. (พ.ศ.)
 ออกตามความในพระราชบัญญัติการผังเมือง พ.ศ. ๒๕๑๘

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เครื่องหมาย

- Recreation area
- Catchment area
- Suggestion City park (300 rai)
- Suggestion District park (100 rai)
- Suggestion Community park (50 rai)

- แนวเขตผังเมืองรวม
- - - - - เขตจังหวัด
- - - - - เขตอำเภอ เขตของเขต
- ทางหลวง ถนน
- ทางรถไฟ
- แม่น้ำ ลำคลอง
- ที่ลุ่ม บึง หนองน้ำ สระน้ำ



ผังเมืองรวมกรุงเทพมหานคร

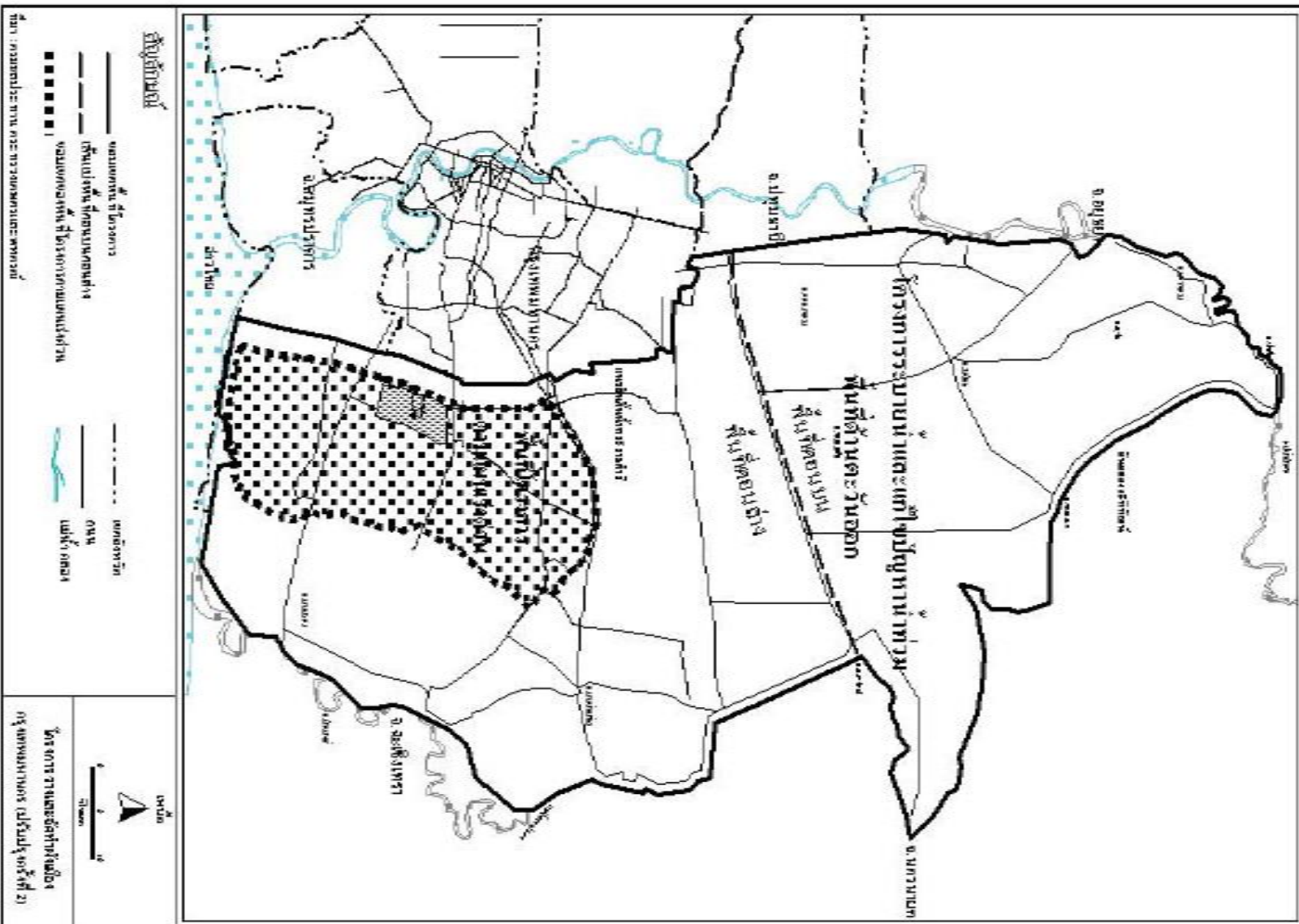
(นายพิชัย โชคพจน์พาณิช)
 ผู้บัญชาการสำนักงานผังเมือง

(นายสมิทธิ์ สุทธิเวช)
 ผู้อำนวยการกรุงเทพมหานคร

Map of Open space in Bangkok (draft version)

Map of Flooding prevention and drainage project for the east of Bangkok

รูปที่ 5.3 แผนที่แสดงพื้นที่โครงการป้องกันน้ำท่วมและระบายน้ำในบริเวณพื้นที่ราบลุ่มภาคตะวันออกของกรุงเทพมหานครและพื้นที่ลุ่มน้ำชายฝั่งภาคตะวันออก



โดย: อุเทนพรพรรณ พิทักษ์

Flooding problems

1) Natural causes

- Rain water that fall within the field or Water for agriculture in the vicinity of the north and the east of Bangkok. This will flow into the area protected by flood slope of the ground level.
- Water from the Northern area along the Chao Phraya River in October and November.
- Storm search and the sea-level fluctuations which affect the water-level fluctuations in Chaoprayariver in October and December.

2) Physical condition causes

- City Growth
- Drainage system
- Land subsidence

Flooding prevention

1) Operate by Bangkok Metropolitan Administration

1.1) Prevent flooding from outside which caused by sea water.

- Construct the levee in Bangkok area along almost all of Bangkok western area and the east line along the Chao Phraya River in Nonthaburi province.
- Construct the levee along the Chao Phraya River, Klong Bangkoknoi and Klong Mahasawat to prevent flooding, which caused the water from northern area and storm search with the length of the current 86 kilometers.

1.2) Prevent flooding from inner area which caused by rain water and drainage system.

- Construct the tunnel to optimize the drainage system and the drainage of flood detention area to the Chao Phraya River directly. There are 4 existing tunnels which are Klong Bangken, Klong Bangsue, Klong Chong-non-sri and Klong Prakanhong.
- Provide catchment area to improve the current drainage Bangkok to accommodate rainfall.
- Create sub-system of enclosed-area in high- densisty communities with flood vulnerability within the line of Bangkok's levee to prevent and resolve the spatial area. 15 areas are on the current operation with the total area of 168.06 square kilometers.

2) Operate by Royal Irrigation Department

- Responsible for the area outside the levee's line, including Khlong Sam Wa, Min Buri, Nong Chok, Ladkrabang, Samut Prakan province and in the Chao Phraya River area. The current operation is to drain from the east of Bangkok over the sea through Samut Prakan with the several installations of large pumping station in Samut Prakan.

“Current perception of climate change related risk (such as floods, water and food supply, land losses, air quality, heat stress, disease outbreaks, etc.) and social/economic vulnerability (such as poverty, investment, capital and opportunity losses, social conflicts and divides, genders, justice, etc.) in your city, e.g., how do they perceive on the differences and linkages between weather/climate risks and social/economic vulnerability?”

- o *Among general public*
- o *Among urban officials, city managers*

Informality Risk and Assessment

The study of climate change and related risk has been heavily studied on flood related risk. Informality which is one of the dominant characteristic of Bangkok Urbanism has been largely ignored. For informality issues, this report is aimed to focus on 1) informal economy and 2) informal settlement which is currently viewed by the general public as non-climate issue, and hence not only ignored by city planning but also perceived as a non-climate factor for risk assessment, that could also exacerbate sector and community vulnerability. The review, hence, aims review a current knowledge on informality of Bangkok. The ensuing question is what would be the risk and vulnerability on informal economy and settlement.

Bangkok Economy and Uneven Development

Bangkok, the capital of Thailand since 1782, marked the beginning of the current Chakkri Dynasty. Nowadays, Bangkok covers an area of 1,443.85 square kilometres. According to the National Statistics Office (NSO) in 2008¹, Bangkok’s total population was 5,710,883 (2,988,570 are women and 2,722,313 are men) with 2,207,453 households. Between 1883 and 1913, Bangkok’s population expanded from 169,000 to over 365,000 people, a growth rate far in excess of the average population growth in the Kingdom. By 1937, Bangkok was 15 times larger than the second-largest urban settlement of Thailand, Chiang Mai (Askew, 2002: 37). Bangkok remains disproportionately larger than Chiang Mai and as a result, Bangkok has manifested more dominant and exaggerated elements in economy, society and culture compared to other urban areas in Thailand (Baker and Phongpaichit, 2005: 204). The urbanisation of Thailand, especially Bangkok, can be explored through its economic boom.

Bangkok’s demographic change is part and parcel of the rise of urbanism in Bangkok. It has been usually estimated that about 15 percent of Thailand’s population resides in the greater Bangkok metropolitan area (Hewison, 1996: 149). The Table below shows population trends in Bangkok from 1985 to 2006 relative to those in Thailand as a whole.

Demographic changes of the population in Bangkok and Thailand as a whole, 1985-1986, 1995-1996, and 2005-2006

Regions	Demographic change								
	1985-1986			1995-1996			2005-2006		
	Birth rate*	Death rate	Growth rate	Birth rate	Death rate	Growth rate	Birth rate	Death rate	Growth rate
Thailand	23.87	6.44	1.74	17.90	6.02	1.19	10.85	6.76	0.66
Bangkok	18.92	3.84	1.51	14.24	3.92	1.03	8.63	4.23	0.65

*Note: Birth and death rates represent figures per 1,000 persons while growth rates represent figures per 100 persons.

¹ In comparison to the whole Kingdom, in 2008, Thailand had a population of 63,389,730 (32,133,861 are women, whereas 31,255,869 were men)

However, the above population numbers are still considered to be quite low. The urbanisation of Bangkok and the currently available data are likely to be underestimated. This is partly because the way data was collected, based on household registrations². Even so, the increasing number of Bangkok's population can not be ignored (ibid: 149).

The increasing population in Bangkok can also be further explored from the angle of urban migration. As discussed in Chapter 4, government policy has been encouraging foreign investment and industrial development through taxation and the provision of cheap labour. Since the decline of the agricultural section in the rural areas, the returns from agricultural production was too small for household reproduction, and the money from Bangkok became a necessity for the reproduction of rural villages. At the same time, government policy ensured that the surplus labour from the agricultural sector would be absorbed into the industrial one. Hence, female and male workers migrated in search of wage-work in Bangkok (Korff, 1989: 16).

Number of migrants (X 1,000) moving to Bangkok (from regions of origin, 1974-1992)

From	1974	1976	1978	1981	1982	1988	1992
North-eastern	24.6	24.9	44.3	53.2	36.4	48.6	155.5 (51.4%)
North	7.7	7.4	10.3	17.0	14.7	19.6	68.6 (22.7%)
South	4.9	6.7	6.3	10.0	9.0	7.8	18.3 (6.0%)
Central	32.8	28.2	32.3	41.8	33.6	32.8	60.2 (19.9%)
Total	70.6	67.7	93.8	122.9	94.0	108.8	302.6 (100.%)
Male	35.9	31.7	38.9	48.6	39.1	41.4	152.9
Female	34.8	36.0	55.8	74.2	54.8	68.3	149.7
M:F	1.03	0.88	0.68	0.65	0.71	0.61	1.02

Source: The National Statistics Office, 1992 (*adapted from Tantiwiranond & Pandey, 1997: 104*)

The number of female and male migrants moving from different regions of the country to Bangkok increased from 70,600 persons in 1974 to 302,600 persons in 1992. The largest portion came from the poorest region, the North-eastern region. Moreover, the trend of female migrants outnumbering male migrants continued until the early 1990s. In 1992, more women (64,300 women) at the young age of 10-19 years migrated to Bangkok compared to men (47,700 men). However, at the older age range of 20-34, more men (72,400) migrated to Bangkok compared to women (57,500 women). In sum, female migrants comprised about 4.7% of Bangkok's population, whereas male migrants comprised at 4.9%. As previously discussed, female migrant workers were mostly employed in services and sales. Male migrant workers were employed in the technical and transportation fields (Tantiwiranond and Pandey: 103-104). As a consequence of government policy being focused on urbanisation, the disparity of Thailand's productivity between the urban areas, especially Bangkok, and the rural areas is apparent, as shown in the Table below.

Regional productivity of Thailand in 1989

Region	% of population	% of GDP
Bangkok	16.0	48.2
Central	16.8	18.4
Northeast	34.6	12.9
North	19.4	11.4
South	13.2	9.1

Source: The Thailand Development Research Institute, 1992 (*adapted from Hewison, 1996: 147*)

² A household registration is an official household census where the address, location and ownership information of a house, including the name and relationships of all members of that household are officially listed. (www.dopa.go.th 30.03.09 10.00)

Such industrialisation also contributed to the rising middle class in Bangkok. The middle class continued to be the main beneficiary of this income and wealth concentration in Bangkok. There is still a large disparity between the lower status and the upper one. The Table below presents the socioeconomic status of the population in Thailand in different regions in 1990.

Socioeconomic status (SES) in Thailand, 1990

SES ³	Bangkok (%)	Other urban areas (%)	Rural areas (%)
Lower	55.1	69.6	78.6
Middle	28.3	20.5	13.1
Upper	16.6	9.9	8.3

Source: Ogilvy & Mather, 1991 (*adapted from* Hewison, 1996: 150)

Urban dwellers have received the greatest benefits as a result of the increasing wealth of the upper and middle classes in the urban area, especially in Bangkok, which amounted to about double of that in the rural areas. Almost half of Bangkok's income earners are considered to belong to the middle or higher classes. This is also reflected in their spending patterns. In 1989, an average of one in three of Bangkok's residents owned a vehicle. At that time, the rate of vehicles purchased per month, which steadily increased, averaged at 12,000 vehicles. The spending power of Bangkok's residents increased rapidly by 17% between 1988 and 1989 (Hewison, 1996: 151, 153). Yet even though the number of the population considered to be in the lower classes in Bangkok was smaller than that of other urban and rural areas, they still comprised more than half of Bangkok's residents. In this way, not only was the disparity between the urban and the rural areas apparent, but also that within Bangkok.

With respect to the aforementioned uneven development between Bangkok and the rural areas, it is apparent that Bangkok provided a variety of jobs for the middle classes as well as cheap labour. Even so, social stratification in the rural areas was small compared to that of Bangkok, where the disparity between the urban rich and the urban poor could not be ignored. Bangkok was the place where the mass media, government departments, and business were located. As a result, Bangkok also had to deal with the heterogeneity and complexity of the working population in Bangkok (Korff, 1989: 16, 22).

Gendered Political Economy and Informal Sector: An Exemplification of Bangkok Uneven Development

(*Perceived*) non-climate issues

- migrant workers dominate the sector
- poor condition of work and cheap labour
- reserve army of workforce
- gendered issues: from a comparative perspective, working women in Thailand have suffered less discrimination than women in many other parts of Asia. Thai women have always worked. Women represent more than half of the Thai population and have always shared productive work with their men.
- Women are attracted to informal sector

³ A relative measure of a person's economic and social position against others, based on income, education and occupation. (www.nida.or.th)

Industry expansion in Thailand during 1960-1990

Sectors	1960	1970	1980	1990
Agricultural, % GDP	39.8	28.3	23.2	12.4
Agricultural, % exports	90.5	70.3	58.3	22.6
Agricultural, % labour force	82.4	79.3	72.5	66.5
Industry, % GDP	18.2	25.3	28.4	39.2
Industry, % exports	1.0	15.0	32.0	63.0
Industry, % labour force	4.2	5.8	7.7	11.2
Services, % GDP	42.0	46.4	46.4	48.4
Services, % labour force	13.4	14.9	19.8	22.3
GDP per capita (constant 1990 US dollars)	\$100	\$195	\$688	\$1,200
Annual growth rate		7.9%	6.9%	5.4%

Source: *adapted from Slagter (2000: 36)*

This striking picture underscores that fundamental change had taken place in the Thai economy by the end of 1980s. There was rapid growth in manufacturing, whereas the percentage of GDP and exports of agriculture had relatively declined (*ibid*: 36). Ever since the 1980s, the value of manufacturing exports has been much greater than that of agricultural exports. In this period, Thailand also attracted labour from the agricultural sector to the non-agricultural sectors and the population shifted from the rural to the urban areas (Kanda, 2000: 382).

Percentage of total employment by industry, 1980 and 1989

Industry	1980		1989	
	Women (%)	Men (%)	Women (%)	Men (%)
Agriculture	74.1	67.8	56.2	57.8
Mining	0.1	0.2	0.1	0.2
Manufacturing	7.1	8.7	14.1	11.0
Construction	0.6	3.2	1.2	6.2
Electricity	0.1	0.5	0.1	0.7
Commerce	9.1	7.4	14.2	9.6
Transport	0.3	3.6	0.6	4.2
Service	8.2	8.6	13.4	10.1
Other	0.0	0.0	0.1	0.1
Total number (thousands)	10,657.4	11,866.3	11,909.0	15,363.5

Source: National Statistical Office of Prime Minister, May 1989 (*adapted from Phananimai, 1996: 281*)

Since the working population in agriculture had declined, manufacturing, commerce and the service sectors absorbed approximately 8 percent of the total work force. More importantly, this development had a significant impact on the expansion of the number of female industrial workers. In 1980, female workers out-proportioned male workers in agriculture and commerce, whereas in 1989 they did so in manufacturing, commerce and the service sectors (*ibid*: 281). Most industries were located in Bangkok and its vicinity and all factories employed female labour which contributed significantly to national income (Attavavutichai, 1992: 55). Such big and small factories, workshops and joint-venture companies, as in the period of accelerating industrialisation, provided a big increase of employment for female labour in Thailand. The most important of these industries were textiles, gem polishing, footwear and simple electronic components which were all export oriented. Conversely, the growth of these industries crucially depended on female labour force (Falkus, 2000: 182). The female labour intensive industries generated 47.7 percent of GDP in 1989 (Phananimai, 1996: 282).

Percentage share of employment by economic sector, 1990-1998

Year	Agriculture			Manufacturing			Construction			Transport			Service		
	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total
1990	30.3	33.7	64.0	5.1	5.1	10.2	0.6	2.8	3.4	0.2	2.1	2.3	10.4	9.7	20.2
1991	27.9	32.4	60.3	5.6	5.5	11.1	0.6	3.2	3.8	0.3	2.4	2.7	11.5	10.6	22.1
1992	34.6	14.2	48.8	9.0	8.5	17.5	4.3	3.6	7.9	0.2	1.0	1.2	13.1	14.6	27.7
1993	26.2	30.5	56.7	6.0	6.3	12.3	0.8	3.9	4.7	0.3	2.5	2.8	6.0	5.4	11.4
1994	26.2	29.8	56.0	6.6	6.0	12.6	0.9	4.3	5.2	0.3	2.5	2.8	6.3	5.7	12.0
1995	24.3	27.7	52.0	6.7	6.8	13.5	1.0	4.7	5.7	0.3	2.1	2.4	6.3	6.3	12.6
1996	23.1	26.9	50.0	6.4	7.0	13.4	1.3	5.4	6.7	0.3	2.7	3.0	6.6	6.1	12.7
1997	23.3	27.0	50.3	6.2	6.7	12.9	1.3	4.8	6.1	0.3	2.6	2.9	6.8	6.3	13.1
1998	19.2	30.8	50.0	7.4	7.2	14.6	1.1	6.2	7.3	0.2	2.0	2.2	5.7	6.2	11.9

Source: National Statistic Survey (*adapted from Kanda, 2000: 381*)

Working women were likely to dominate men in the agricultural, manufacturing and service sectors, whereas they were poorly represented in transport and construction (*ibid: 381-382*). As in the 1970s-1980s, the reason that the manufacturing and service sectors preferred female workers was partly because women were seen as being more likely to put up with low pay, short-term employment, repetitive, and labour-intensive work than men. As Elson and Pearson (1981) argue, as in other countries in the global South women are attractive to employers. Global factories reproduce similar models of organisation where women's low pay and authority is concentrated, whereas men occupy most of the supervisory and managerial ranks (Elson and Pearson, 1981: 98-99)

Besides as factory workers, women in urban areas are also prominent in trade and professional jobs. The merchant culture of the Sino-Thai population that was instrumental in establishing Bangkok in early twentieth century capitalism still remains an important part of business expansion in Bangkok and neighbouring regions today (Reynolds, 1998: 117). In the professional area, Thai women are active, often in senior positions, as teachers, nurses, and more recently as doctors. Thailand also has a slightly higher proportion of women serving in clerical (1.8% of women, 1.6% of men) and sales positions (6.7% of women and 4.5% of men) (Thomson and Bhongsvej, 1995: 60). Furthermore, in the areas of business ownership and management there is also a high degree of female activity. Thai women have long held the right to own and manage property and are often engaged in business activities on their own account. Much female economic activity, however, is carried out behind the scenes. Hence, women own-account workers only constituted 10% whereas 23.5% were men in the 1998 national statistic (Kanda, 2000: 382). Such perceptions reflect women's traditional role as the rear leg of an elephant, avoiding women as leaders in the past. "Men have prestige built into their manhood and recognized by their superior religious status with which women, by definition, cannot compete." (Ward, 1963: 97 *quoted in Springer et al, 1981: 727*) The percentage of employment distribution by work status and gender from 1993-1998 demonstrated that in almost every work status, government, private, and own-account worker, male employment was higher than that of female. Many formal institutions, for example religion and the political arena, continue to be dominated by males. Moreover, professional women have lower positions and are paid less than men. As modernisation occurs, occupations tend to become structured along institutional lines. When these occupations become important sources of status, men and women find themselves in direct competition. The result is a decline of female equality, which traditionally has been based mainly on participation outside formal institutions (Kanda, 2000: 378-384; Springer *et al,*

1981: 727). Although Thai women have traditionally participated actively in family and economic life, such freedom and equality with males has not been carried over into modern occupations since the 1970s.

Not only did the female work force face limited employment, but their work conditions were also poorer compared to that of the male work force. Nearly all Thai women factory workers were paid less than the legal minimum wage and they worked long hours, often more than 50 hours a week (Falkus, 2000: 185). Although legislation provides equal rights for men and women, including equal pay for work of equal value, women accounted for 46 percent of the labour force but earned only 37 percent of income in 1999. Most women earn only half of the men's income in all non-professional jobs, including manufacturing services and management (Thomson and Bhongsvej, 1995: 60-61).

Women provide cheap labour because they are paid less than their marginal product which leads to excess profit. For example, in the garment industry, which was dominant in 1990s, the majority of workers were paid piece-rates. Hence, the prevalence of piece-rate, subcontracting and female employment were favoured. Paying piece-rates was a way to avoid minimum wage and other government labour legislation. Costs could then be minimised. In some cases, it seemed that women workers could combine factory and service sector employment with household activities such as family responsibilities provided that they were a flexible and undemanding work force (Falkus, 2000: 185).

In 1997, Thailand faced an economic crisis⁴ after a period of economic boom when the benefits of growth trickled down to most Thais and improved economic well-being substantially. Prior to the crisis, the population of the poor decreased from 57% in 1962/63 to 33% in 1975/76 and to 14% in 1992 (Santrisart, 2005: 138). As presented in Table 4-3, Thailand saw significant increases in per capita incomes from about 18,000 baht in 1980 to 30,000 baht in 1990. However, even then, the benefits of economic growth were not equally distributed. In 1990, most of the rural working population (79%) earned less than 4,000 baht/month, whereas more than half of the working population in Bangkok (57%) and those in other urban areas (51%) earned more than 8,000 baht/month (Hewison, 1996: 146-147). With the onset of the Thai economic crisis, the incidence of poverty significantly increased as a result of the crisis, from 11.4% in 1996 to 12.9% in 1998 (Phongpaichit and Baker, 2000: 96). The Thai economic crisis seriously worsened the living conditions of the poor. It also raised local prices of commodities, deteriorated social services provided by the state and led to a decrease in income and output. The resultant costs and responsibilities were transferred to women who maintained the daily routine of household tasks (Surivasarn *et al*, 2003: 10-11). The impact of the economic crisis on employment resulted in reverse migration of unemployed former workers from the non-farming sectors from Bangkok to the farming-sectors of other regions. As a consequence, there was an increase in underemployment in the agricultural sector. It should be noted that most of the reverse female and male migrants were from the construction sector whereas new migrants from the central and northern parts of the country still came to Bangkok. More importantly, the crisis strongly affected employed persons under 30 years of age and those with under primary level education, whereas employment was increased by one million in 1998 for those with secondary and higher education

⁴ Due to the dominant policies of export orientation and foreign investment in the 1980s to 1990s, most foreign capital inflows were in the form of short-term and speculative investment. The rapid economic growth and large amount of foreign investment was encouraged by a fixed foreign exchange rate in the 1990s. Such investment looked for quick profits in niche markets which then created a volatile investment environment. In 1996, this resulted in a downturn of external demand which decreased the value of exports. Consequently, the cost of imports was raised and in 1997 Thailand was forced to float the Thai currency (*Baht*) due to an exhaustion of foreign exchange reserves. The sudden devaluation of the Thai Baht increased foreign debts and hence led to the Thai economic crisis (Suriyasarn *et al*, 2003: 9).

(Sarntisart, 2005: 154-155). More women were unemployed than men. They were also less likely than men to be offered training or re-training. Women labourers could not progress at work because they received no training and lacked the knowledge to deal with the technology used in the workplace (UNIFEM, 1998: 4). Service sector employment rose during the crisis years, from 1997 to 1999. Service sectors such as tourism, entertainment and hospitality attracted women. They increasingly entered the services and informal sectors to mitigate the effects of crisis (Surivasarn *et al*, 2003: 10-11). Because of the above constraints and longstanding poor work conditions of women, they continued to work in poor conditions. Not only were most of the women laid off, but they also had less chance of being re-hired by formal sectors and remained in informal and service sectors.

With respect to informal workers⁵, there were 4.4 million female workers in the informal sector in 1997. Women are also attracted to the informal sector because of it provides for easy entry, is labour intensive, usually small scale with low cost, and requires technology utilizing only low skills or less formal education. Because of the co-existence of their economic and domestic roles, women could compromise between family obligations and income earning by adapting both to their own circumstances (Kanda, 2000: 383-384). With respect to women entrepreneurs in Thailand engaged in family run enterprises, specific data is not readily collected from the national census on labour force. However, it is apparent that wives and daughters have been involved not only in family businesses but also engaged in business activity on their own to supplement the family income. Especially in urban areas, female traders are almost double in number than male traders. However, there are problems encountered in advancing women in the informal sectors. These include lack of market information, limited access to credit, inadequate linkage with technological resources, inadequate support services, too much competition, lack of health and child care facilities and lack of professional business and financial management skills (Aganon, 2000: 9).

Informal Settlement: An Exemplification of Spatial Uneven Development

The economic developments of Thailand, urbanisation, and the changing socioeconomic characteristics of her cities have also led to uneven spatial development in Bangkok. Nowadays, Bangkok is one of the world's most cosmopolitan cities. It is dominated by the manufacturing production of multinational corporations, commercial sectors, financial sectors, the tourism industry and the service sectors. It also represents the centre of the economy, political life, and Thai society richly articulated in such areas such as culture, fashion and lifestyle (Askew, 2002: 227). However, like many other developing cities, Bangkok's spatial development has been uneven.

Residential types of low and lower-middle income settlements:

- riverside or canal squatter settlement
- apartment block
- rent room

(*perceived*) non-climate issues

- settle on public land, hence lack of land tenure security
- deprived space/area, hence facing poor sanitation and quality of life

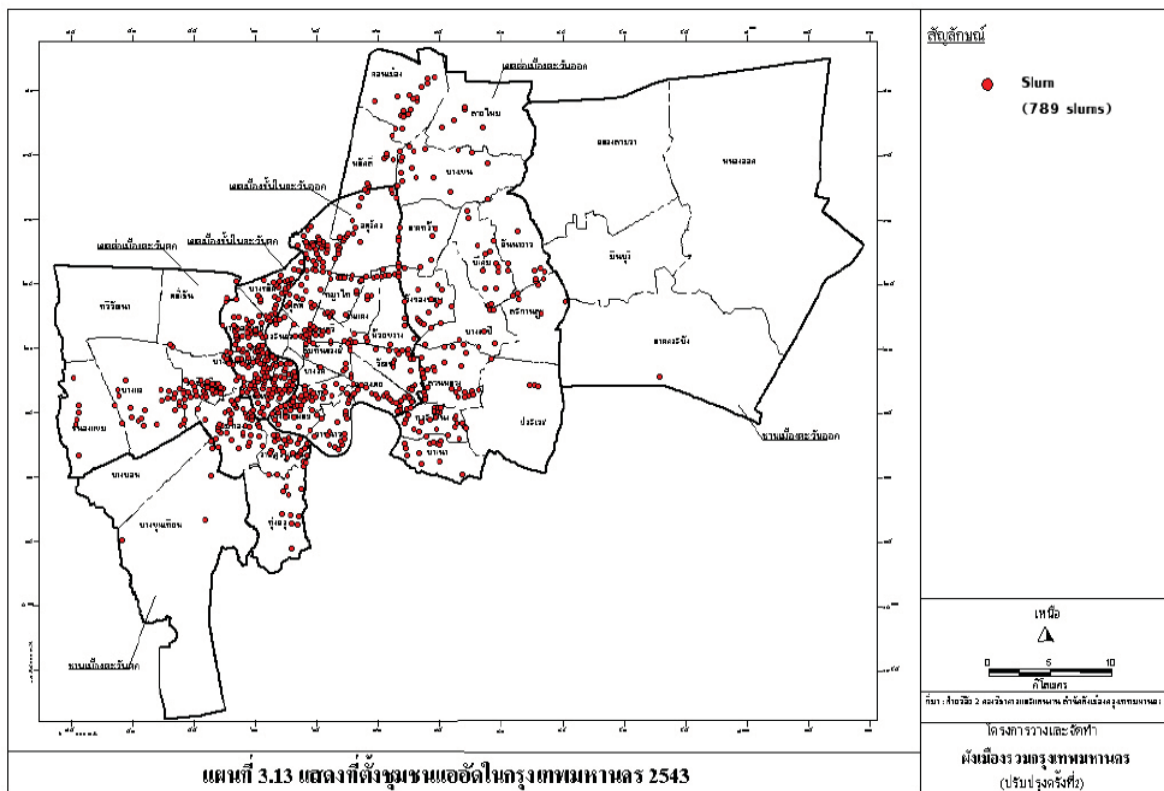
⁵ "The informal sector includes such activities as domestic work in other households, traditional handicraft production and manufacturing of export goods and small-scale enterprises with less than 10 workers." (Kanda: 2000: 383-389)

“Is there an existing urban GIS information base that may be used for climate risk and vulnerability assessment? What is included?”

During the economic downturn in 1997, even though there was a low rate of urbanisation, economic performance actually improved in a manner. Bangkok’s residents living in the core were able to adjust and inner city, urban areas provided significant opportunities for them. Hence, the already available complexity and heterogeneity of *Sois* in inner Bangkok absorbed excess labourers, especially in the informal sectors. Consequently, the physical structure of Bangkok’s inner core became comprised of tourists, hospitality and retail zones, financial districts, government areas and informal business sectors— mixed land use (ESCAP, 2005: 125)

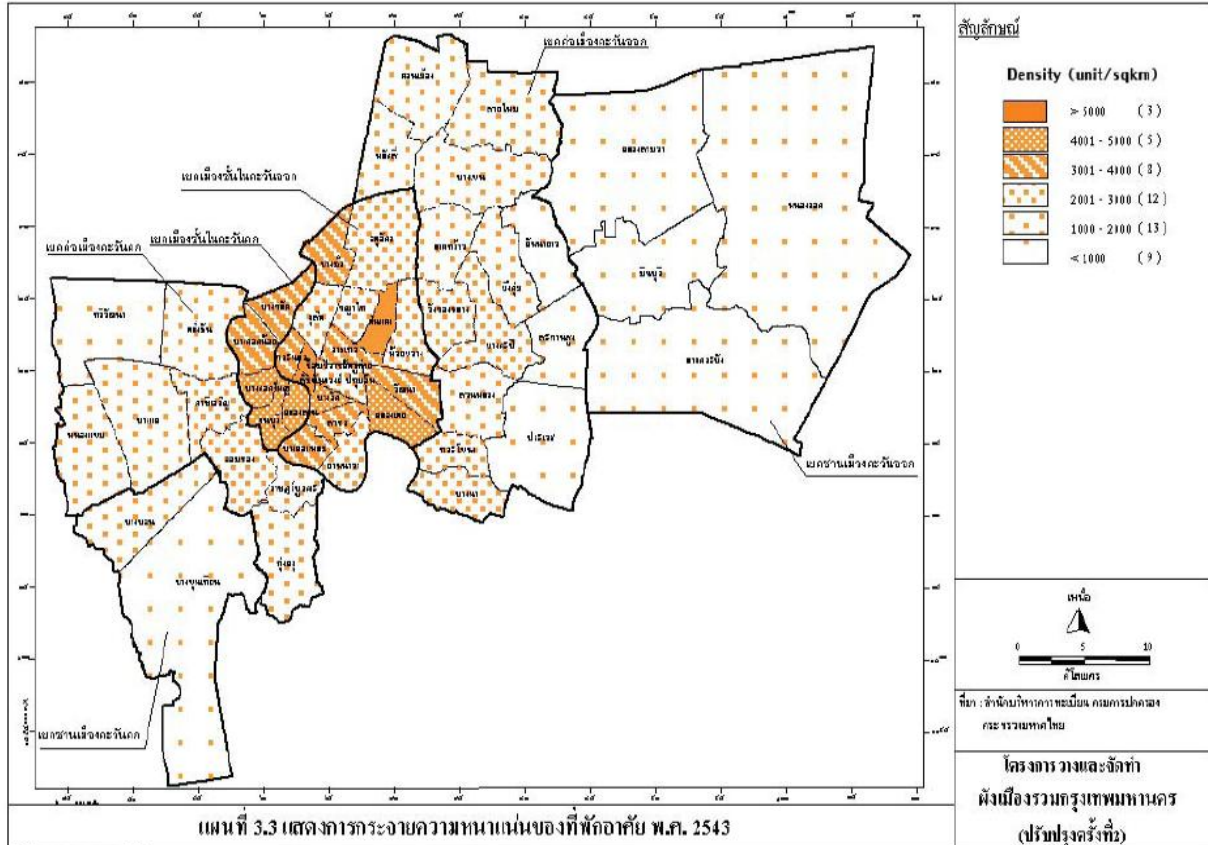
Even though a policy of decentralisation of Bangkok has been implemented, it failed due to the low level of job dispersion. Employers continue to commute to inner Bangkok for work. This pattern occurs partly because almost all land in Bangkok is privately held. Hence new housing has been developed on the periphery and there is no affordable land for the construction of public housing to bring people closer to their workplace (Punpuing, 1993: 8,9). Hence, the inner core still absorbs residents and commuters, and creates multiple land use patterns. There are layers of labour markets and uses in the economies and ecologies of the inner Bangkok which operate with relative autonomy from the luxury condominium inhabitants. These include services for people working in both formal and informal sector and living locally, such as dressmakers, hairdressers, laundries, and etc.

The following three maps done by BMA suggest the characteristic of low-income settlement which is clustered along the Chao Praya River and juxtaposed the business district, especially the large shopping mall in the urban core.



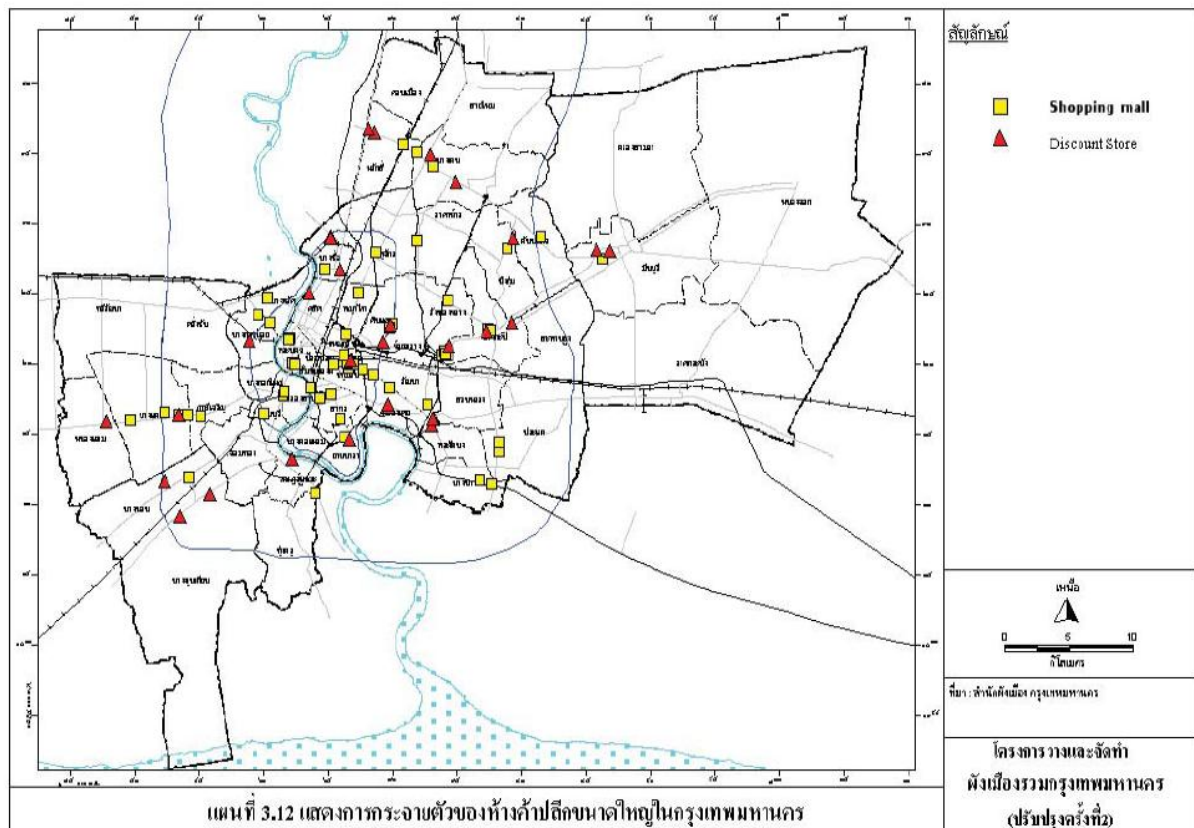
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Map of Slum areas in 2000



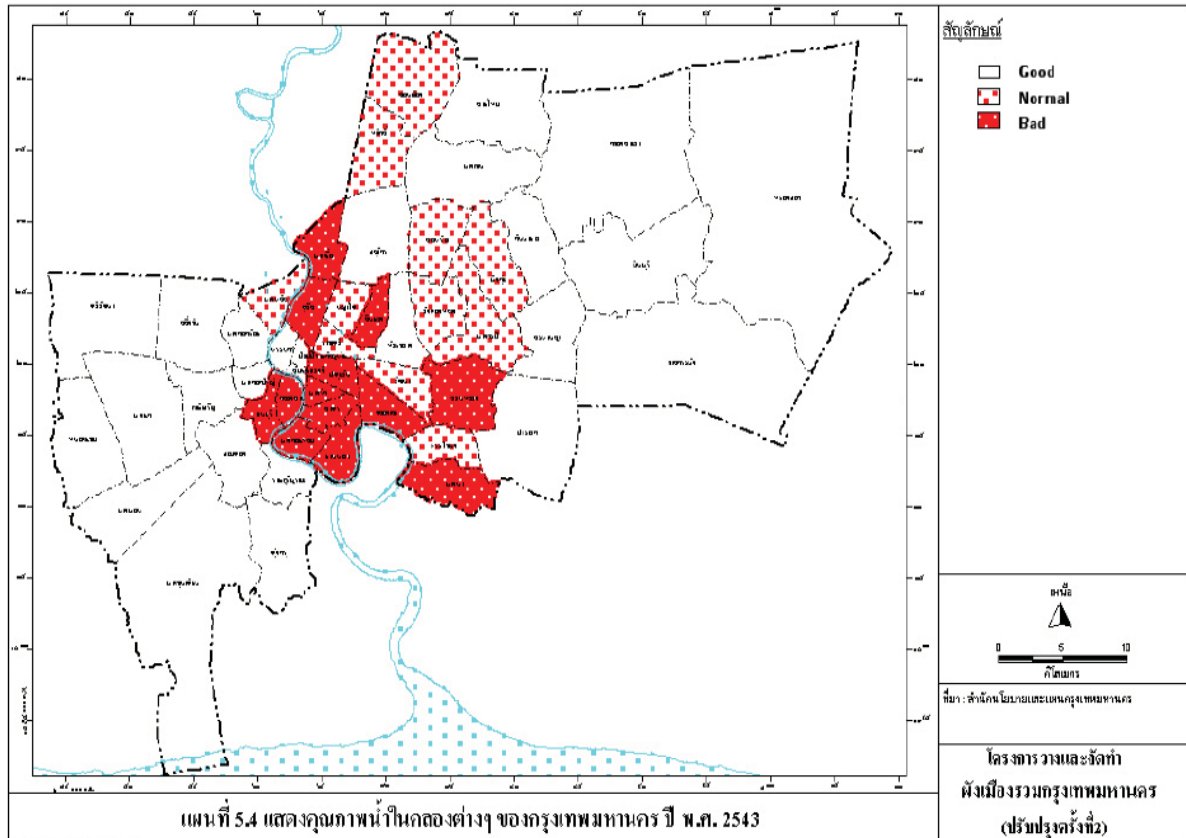
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Map of Residential density in 2000



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Map of large retail store in Bangkok



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