CHAPTER 2
CITY DESCRIPTIONS

2.1 TOPOGRAPHY

2.1.1 River Basin

Bangkok covers an area of 1,569 km² located in the delta of the Chao Phraya River Basin, which is the largest basin in the country, covering an area of 159,000 km² or about 35% of the total land area of the country. There are two main rivers bisecting the delta area: the Tha Chin River on the west and the Chao Phraya River (the main stream) on the east. The basin forms up by 4 large tributaries: the Ping, Wang, Yom, and Nan originate from the mountainous terrain in the northern part of the country. These four tributaries flow southward to join each other in Nakhon Sawan to become the Chao Phraya River. The river flows southward through a large alluvial plain to reach the sea at the Gulf of Thailand as illustrated in Figure 2.1-1.

Figure 2.1-1 River Network in the Chao Phraya River Basin

The basin area is flat at an average elevation of 1 to 2 m from the mean sea level (m.MSL), with certain spots where the elevation is lowered down to the sea level due to land subsidence. There are a number of canals crisscrossing the whole basin. Bangkok straddles the Chao Phraya River 33 km north of the Gulf of Thailand. Due to the flatness of the area and close proximity to the seashore, the area annually faces the problems of floods from rivers from the north and inundation due to the high tide from the sea. The topography of the Lower Chao Phraya River Basin is shown in Figure 2.1-2.

Figure 2.1-2 Topography of the Lower Chao Phraya River Basin
2.1.2 Land Subsidence

From observed data, the average land subsidence rate in the Bangkok Metropolitan Region (BMR) has gradually reduced from 10 cm per year to 1-2 cm per year from 1978 to 2007. Furthermore, during the last 5 years (2002-2007), the average land subsidence rate has reduced to 0.97 cm per year. Therefore, it is expected that the land subsidence rate would reduce by 10% per year. Thus, the accumulated land subsidence during 2002-2050 (48 years) would spatially vary from 5 to 30 cm depending on location as shown in Figure 2.1-3.

![Figure 2.1-3 Land Elevation in 2002 and 2050 due to Land Subsidence](image)

Source: Royal Thai Survey Department (RTSD) and Panya Consultants’ forecast

2.2 CLIMATE

2.2.1 General

The climate of the Chao Phraya River Basin belongs to the tropical monsoon. The average annual rainfall over the basin is 1,130 mm, varying from 1,000 to 1,600 mm and registering higher in the northeastern region of the basin. According to the rainfall pattern, about 85% of the average annual rainfall occurs between May and October. Tropical cyclones occur between September and October and may strike the basin. In this case, rainfall continues for a long period of time in a relatively wide area. The peak river discharge is registered in October, the end of the rainy season, and severe flood damage may arise with high tide in this period. The mean temperature ranges from 26°C to 31°C. Its maximum temperature is in April and its minimum is in December. The evaporation (Class-A Pan) in the basin is normally at its highest in April and lowest in October with an average annual value of about 1,700 mm.
2.2.2 Climate Change

The Intergovernmental Panel on Climate Change (IPCC) issued a Special Report on Emissions Scenarios (SRES). The scenarios are grouped as four Families (A1, A2, B1, and B2) with subsets, which each have different assumptions on the trend of global development. They are summarized as follows:

1) **A1**: The A1 scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three groups are distinguished by their technological emphasis: fossil intensive (A1FI), non-fossil energy sources (A1T), or a balance across all sources (A1B) (where balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end-use technologies);

2) **A2**: The A2 scenario family describes a very heterogeneous world. The underlying theme is self-reliance and preservation of local identities;

3) **B1**: The B1 scenario family describes a convergent world with the same global population that peaks in mid-century and declines thereafter as in the A1 storyline, but with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies; and

4) **B2**: The B2 scenario family describes a world in which the emphasis is on local solutions to economic, social and environmental sustainability.

An illustrative scenario was chosen for each of the six scenario groups (A1B, A1FI, A1T, A2, B1 and B2). The IPCC AR4 projects that global greenhouse gas emissions will continue over the next few decades and that current warming trends and sea level rise will be larger than those observed in the latter 20th Century. It also provides some projected regional impacts, including the following for Asia:

1) By the 2050s, freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease;

2) Coastal areas, especially heavily-populated mega-delta regions in South, East and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some mega-deltas, flooding from the rivers;

3) Climate change is projected to compound the pressures on natural resources and the environment associated with rapid urbanization, industrialization and economic development; and

4) Endemic morbidity and mortality due to diarrheal disease primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in the hydrological cycle.

As part of the current study, the Japan Bank for International Cooperation (JBIC) commissioned the Integrated Research System for Sustainability Science (IRS3) of the University of Tokyo to investigate the projected future changes in precipitation, temperature and sea level rise pertinent to Bangkok. Based on analysis of a subset of the models used for the Fourth Assessment Report (AR4) of the IPCC, the IRS3 reported that the mean (June-August) basin precipitation for Bangkok would increase by 3 and 2% by 2050, corresponding to A1FI and B1 IPCC climate scenarios. Temperature increases in 2050 would be 1.9°C and 1.2°C while the sea level would rise 0.29 and 0.19 m for A1FI and B1 scenarios.

For the current study, forecasts provided by the IRS3 were used.
2.2.3 Sea Level Rise

In the Upper Gulf of Thailand (Bangkok, Samut Prakarn, Samut Sakhon, and Samut Songkram), the relative sea level rise is about 1-2 cm per year. The average value is 1.3 cm per year, implying a 3 mm per year rate of sea level rise considering a land subsidence rate of 1 cm/year. By 2050, the sea level should rise by 12.3 cm from 2009 to 2050. If the accumulated land subsidence in 2050 is taken as 20 cm, the relative sea level rise would be 32.3 cm.

Figure 2.2-1 Samut Prakarn Flood in September, 2002

2.2.4 Storm Surge

In the Gulf of Thailand, three storm surges occurred in the recent past. In 1962, the storm surge accompanying tropical storm Harriet caused severe impacts on the Lame Taloom Pook peninsula in Southern Thailand. More than 900 people were killed. In 1989, typhoon Gay also produced storm surge and attacked the eastern coast of Chumphon and along the Rayong coast in the inner Gulf area. In 1997, typhoon Linda originated in the South China Sea and upgraded to typhoon intensity shortly after entering the Gulf of Thailand. The cyclone turned northwestward following steering from the subtropical ridge.

Figure 2.2-2 Storm Tracks in the Gulf of Thailand

Typhoon Linda caused strong winds and heavy rainfall. A significant wave height of 3-4 m was measured. Linda weakened slightly to a wind velocity of 50 knots before it made landfall in Thabsakea, Prachuap Khiri Khan province. It should be noted that no typhoon has ever entered the Upper Gulf of Thailand. However, from the propagation of Linda’s track, maximum storm surge at the Chao Phraya River mouth of 0.61 m was estimated.

Source: The Meteorological Department (TMD), 2008
2.3 **SOCIO-ECONOMY**

2.3.1 **Administration**

The administration of Thailand comprises three levels, namely central, provincial, and local. The central administration comprises 20 ministries and 164 departments, all located in Bangkok. The provincial administration comprises 75 provinces (Changwat), 877 sub-districts (Amphoe/King-Amphoe), 7,255 sub-districts (Tambon), and 74,944 villages (Moo Ban). Local administration comprises provincial administration organization, municipalities, the Tambon Administration Organization (TAO), and the Special Local Administration (SLA). Bangkok is an SLA along with Muang Pattaya (Appendix A, page A-11). Figure 2.3-1 shows 50 districts of Bangkok and 6 districts of Samut Prakarn.

2.3.2 **Population**

The BMR includes Bangkok and five vicinity provinces: Samut Prakarn, Samut Sakhon, Nonthaburi, Pathum Thani, and Nakhon Pathom. As of December 31, 2007, the total population of BMR was 10.07 million. The average growth rate during the 5-year period was 0.64% with the highest rate in Pathum Thani (4.95%). The average population density of BMR was 1,297 per km² with the highest density in Bangkok of 3,644 per km². The population in BMR for the period 2003 to 2007 is shown in Table 2.3-1.

<table>
<thead>
<tr>
<th>Province</th>
<th>No. of Population</th>
<th>Growth Rate (%)</th>
<th>Density (people per km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2003</td>
<td>2004</td>
<td>2005</td>
</tr>
<tr>
<td>Bangkok</td>
<td>5,844,607</td>
<td>5,634,132</td>
<td>5,658,953</td>
</tr>
<tr>
<td>Samut Prakarn</td>
<td>1,045,850</td>
<td>1,049,416</td>
<td>1,077,523</td>
</tr>
<tr>
<td>Samut Sakhon</td>
<td>448,199</td>
<td>442,687</td>
<td>452,017</td>
</tr>
<tr>
<td>Nonthaburi</td>
<td>924,890</td>
<td>942,292</td>
<td>972,280</td>
</tr>
<tr>
<td>Pathum Thani</td>
<td>739,404</td>
<td>769,998</td>
<td>815,402</td>
</tr>
<tr>
<td>Nakhon Pathom</td>
<td>812,404</td>
<td>798,016</td>
<td>808,961</td>
</tr>
<tr>
<td>BMR</td>
<td>9,815,354</td>
<td>9,636,541</td>
<td>9,785,136</td>
</tr>
</tbody>
</table>

Source: Department of Provincial Administration (DOPA), 2008

These numbers are based on the registration record and do not include the non-registered population. At present, there is no official statistical record on non-registered population in Thailand besides the estimation by the Department of City Planning (DCP), BMA. In 2007, the estimated non-registered population in Bangkok was 3.25 million. Therefore, the actual population of Bangkok in 2007 would be approximately 9 million.

To forecast the population in 2050 for BMR, the information on population projections for Thailand 2003–2030 prepared by NESDB was used as a base for the estimation. In the NESDB report, the projection was made to year 2030 for the whole kingdom and to year 2025 and 2020 for Bangkok and other provinces respectively. This projection was made at the provincial level and not for districts and sub-districts. In projecting the population to 2050, a regression function is applied. The summary of the projection with the non-registered population taken into account is shown in Table 2.3-2.
Figure 2.3-1 Districts of Bangkok and Samut Prakan

Table 2.3-2 Population Projection including Non-registered (2050)

<table>
<thead>
<tr>
<th>Province</th>
<th>2008</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangkok</td>
<td>10,763</td>
<td>10,796</td>
<td>10,705</td>
<td>10,392</td>
<td>10,082</td>
<td>10,539</td>
<td>10,544</td>
<td>10,547</td>
</tr>
<tr>
<td>Samut Prakan</td>
<td>1,286</td>
<td>1,320</td>
<td>1,391</td>
<td>1,438</td>
<td>1,445</td>
<td>1,469</td>
<td>1,507</td>
<td>1,537</td>
</tr>
<tr>
<td>Samut Sakhon</td>
<td>565</td>
<td>579</td>
<td>607</td>
<td>624</td>
<td>630</td>
<td>640</td>
<td>656</td>
<td>669</td>
</tr>
<tr>
<td>Nonthaburi</td>
<td>965</td>
<td>978</td>
<td>1,011</td>
<td>1,029</td>
<td>1,041</td>
<td>1,055</td>
<td>1,076</td>
<td>1,092</td>
</tr>
<tr>
<td>Pathum Thani</td>
<td>815</td>
<td>833</td>
<td>869</td>
<td>892</td>
<td>900</td>
<td>913</td>
<td>935</td>
<td>951</td>
</tr>
<tr>
<td>Nakhon Pathom</td>
<td>958</td>
<td>976</td>
<td>1,017</td>
<td>1,046</td>
<td>1,050</td>
<td>1,064</td>
<td>1,087</td>
<td>1,105</td>
</tr>
<tr>
<td>BMR</td>
<td>15,352</td>
<td>15,482</td>
<td>15,600</td>
<td>15,421</td>
<td>15,148</td>
<td>15,680</td>
<td>15,805</td>
<td>15,901</td>
</tr>
</tbody>
</table>

Unit: 1,000 people

Source: Panya Consultants’ calculation
2.3.3 Economy

The BMR is the economic center of Thailand. Bangkok is the headquarters for all of Thailand’s large commercial banks and financial institutions. The east of Bangkok and Samut Prakarn are marked as an important industrial zone. In 2006, the Gross Domestic Product (GDP) of the BMR was 3,352 billion baht, or 43% of the country’s GDP (7,830 billion baht). The annual average growth rate was 7.04%. Bangkok’s GDP per capita was 311,225 baht (Table 2.3-3).

Table 2.3-3 GDP at 2006 Market Prices of the BMR

<table>
<thead>
<tr>
<th>Province</th>
<th>GDP (billion Baht)</th>
<th>% GDP of the whole Kingdom</th>
<th>YOY Growth Rate (%)</th>
<th>GDP per Capita (Baht)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangkok</td>
<td>2,135</td>
<td>27.26</td>
<td>5.14</td>
<td>311,225</td>
</tr>
<tr>
<td>Samut Prakarn</td>
<td>514</td>
<td>6.57</td>
<td>7.71</td>
<td>404,807</td>
</tr>
<tr>
<td>Samut Sakhon</td>
<td>278</td>
<td>3.55</td>
<td>10.76</td>
<td>533,159</td>
</tr>
<tr>
<td>Nonthaburi</td>
<td>103</td>
<td>1.32</td>
<td>6.71</td>
<td>85,659</td>
</tr>
<tr>
<td>Pathum Thani</td>
<td>189</td>
<td>2.41</td>
<td>21.72</td>
<td>250,406</td>
</tr>
<tr>
<td>Nakhon Pathom</td>
<td>133</td>
<td>1.70</td>
<td>10.01</td>
<td>138,507</td>
</tr>
<tr>
<td>BMR</td>
<td>3,352</td>
<td>42.81</td>
<td>7.04</td>
<td>289,715</td>
</tr>
</tbody>
</table>

Remark: Year to Year
Source: The Office of National Economic and Social Development Board (NESDB), 2007

To project the BMR economy to 2050, the exponential regression function is applied by using GDP at constant 2007 prices as a base year. The summary of the moderate growth projection of the GDP of the BMR is presented in Table 2.3-4.

Table 2.3-4 GDP Projection for the BMR (2050)

<table>
<thead>
<tr>
<th>Province</th>
<th>2008</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangkok</td>
<td>2,334</td>
<td>2,541</td>
<td>3,163</td>
<td>3,969</td>
<td>4,974</td>
<td>6,226</td>
<td>9,765</td>
<td>15,314</td>
</tr>
<tr>
<td>Samut Prakarn</td>
<td>582</td>
<td>642</td>
<td>809</td>
<td>1,011</td>
<td>1,265</td>
<td>1,585</td>
<td>2,485</td>
<td>3,897</td>
</tr>
<tr>
<td>Samut Sakhon</td>
<td>270</td>
<td>306</td>
<td>386</td>
<td>485</td>
<td>605</td>
<td>758</td>
<td>1,189</td>
<td>1,865</td>
</tr>
<tr>
<td>Nonthaburi</td>
<td>106</td>
<td>117</td>
<td>147</td>
<td>184</td>
<td>231</td>
<td>289</td>
<td>453</td>
<td>711</td>
</tr>
<tr>
<td>Pathum Thani</td>
<td>219</td>
<td>236</td>
<td>303</td>
<td>374</td>
<td>468</td>
<td>587</td>
<td>920</td>
<td>1,443</td>
</tr>
<tr>
<td>Nakhon Pathom</td>
<td>131</td>
<td>145</td>
<td>182</td>
<td>228</td>
<td>285</td>
<td>358</td>
<td>561</td>
<td>879</td>
</tr>
<tr>
<td>BMR</td>
<td>3,642</td>
<td>3,985</td>
<td>4,991</td>
<td>6,250</td>
<td>7,827</td>
<td>9,802</td>
<td>15,373</td>
<td>24,110</td>
</tr>
</tbody>
</table>

Source: Panya Consultants’ calculation

2.3.4 Poverty

Poverty incidence is measured at the household level by comparing per capita household income against the poverty line - which is the income level that is sufficient for an individual to enjoy society’s minimum standards of living. If an individual’s income falls below the poverty line, he or she is classified as poor. In 2007, 0.6% or 88,361 people in the BMR were poor. The poverty line in 2007 for the BMR was 1,638 baht per person per month. A summary of the poverty line, the proportion and the number of poor in each province of BMR is presented in Table 2.3-5.

It has to be noted that this accounting of the poor (88,361 people) is the official number based on people registered in the BMR populace. However, most of the poor are living in condensed housing and are non-registered. Statistics show 768,220 people living in 133,317 housing units of the condensed housing area. Therefore in the flood impact assessment on the poor this housing unit and population will be used as a base for the assessment of income loss of the poor.
2.4 CITY PLANNING

Bangkok’s oldest sector, the area enclosed within a loop of the Chao Phraya River, constitutes the central core of BMA. Major land uses in the core area include the King’s Grand Palace, major temples, government offices, educational establishments, and 2-4 story row houses that serve as commercial retailing as well as living quarters. This area has been declared a national historical conservation area, and construction of high-rise buildings is forbidden.

Inner city districts are fully developed and densely populated and the land has already been utilized to near saturation point. Land uses in this area are intensified by vertical development in the form of high-rise buildings for offices and dwellings. The city expanded its urbanized areas in a V shape to the southeast and north directions along Sukhumvit and Phahol Yothin highways. The total built up area of Bangkok spreads from Nonthaburi in the north to Samut Prakarn in the south. One-fourth of Bangkok’s area is still classified as agricultural land use, which is about the same size as residential land use. The proportion of land use in Bangkok is presented in Figure 2.4-1.

Although modern urban planning came to the kingdom nearly one-half century ago, implementation still poses a considerable challenge. For example, the majority of development projects in Bangkok were designed to solve immediate problems. Projects frequently squandered resources because they were not part of a broader and long-term strategy. Moreover, the government’s policy represented a one-sided approach, which disregarded the management of surrounding towns, which have been planned separately in a piecemeal fashion.

To remedy these deficiencies, attempts have been made by planning agencies to prepare long-term, large scale national and regional development plans. A major step in the spatial planning process was the drafting of the fifty-year or 2057 (B.E.2600) national land use comprehensive plan that finished in 2007. Guided by the national plan, five regional development plans have been issued including a BMR Plan. The basic aim of the BMR plan is to give Bangkok the opportunity to shift from the relentless quantitative growth it experienced in recent decades to focus on qualitative...
growth in order to upgrade the quality of life of Bangkok residents. The major strategy aims for Bangkok to become “a center of culture, administration, service, and economic production using only high-skilled labor and sophisticated technology”.

The development concept for the BMR is a multipolitan pattern with outlying areas developed as planned communities with a high degree of self-sufficiency, thereby ensuring residents need not commute to Bangkok for employment or high-level services. Economic activities will be decentralized from Bangkok and thereby diffuse growth from the capital to the five vicinities. The BMR land use conceptual plan for 2057 is shown in **Figure 2.4-2**. It illustrates tightened urban areas within the network of expressways bounded by large environmental protection areas to divert floods from the center.

![Figure 2.4-2 Land Use Conceptual Plan of the BMR (2057)](image-url)
2.5 SECTOR INFORMATION

2.5.1 Buildings and Housing

Over the past decade (1997-2007), housing stock in Bangkok has been increasing at 2% per year in response to socioeconomic development (Appendix B, page B-10). The increase of housing stock in the neighboring province of Pathum Thani is even higher (5% per year) (Figure 2.5-1). Individual and row housing constitute the largest groups of houses by structure type (Figure 2.5-2).

Concerning condensed housing neighborhoods (slums), the July 2008 housing data lists 805 such neighborhoods, reduced from 850 neighborhoods in 2005. The reduction can be attributed to destruction by fire and conversion to other land use. The analysis shows that the condensed housing neighborhoods are clustered around 5-10 km from the city center. Statistics report there are 768,220 people living in 805 condensed housing neighborhoods with 133,317 housing units and 186,017 households.
2.5.2 Transportation

The principal transportation network in the BMR comprises roads, rail, and waterways (Appendix C, page C-1) (Figure 2.5-3). The first urban expressway, the Chalerm Maha Nakhon Expressway, was opened in 1981. Since the mid-1990s, an extensive series of major road and expressway projects have been completed. Nevertheless, traffic jams on Bangkok's surface roads remain as private vehicle usage continues to outstrip infrastructure development.

The Bangkok Skytrain (BTS) was opened to the public in 1999 and connected to the MRT subway system in 2004. Bangkok commuters now have a convenient and fast way for travel to commercial areas like Sukhumvit Road. A new high-speed elevated railroad called the Suvarnabhumi Airport Link, currently under construction, will link the city with the airport.

Buses are the backbone of the passenger transportation system in Bangkok, accounting for more than 50% of all passenger trips and 75% of trips during the peak period. Bus service is provided by the Bangkok Mass Transit Authority (BMTA) and it operates throughout Bangkok as well as to adjoining provinces.

The waterway network was well-used when Bangkok was called “The Venice of the East”. Nowadays, the Chao Phraya express boats and Klong Saen Saep canal service boats have experienced a continuous decline in passengers due to mass transit diversion options.

2.5.3 Water Supply and Sanitation

The water supply and sanitation system in the BMR is presented in Figure 2.5-4. The Metropolitan Waterworks Authority (MWA) operates 4 treatment plants that provide the water supply to Bangkok, Samut Prakarn and Nonthaburi. Water resources are the Chao Phraya and Tha Chin Rivers. MWA prepared a plan to expand the serviced area and improve production capacity from 5.52 to 6.32 million cubic meters (MCM)/day. In the last 5 years, the average consumption of residential and non-residential users is 0.48 and 3.71 m³/day/user and the average water revenue of residential and non-residential users is 2.06 and 2.83 baht/m³, respectively. The water consumer projections in 2050 are 7.13 million for residences and 1 million for non-residences (Appendix D, page D-4).

The BMA central environmental control plants have a total capacity of 1 MCM/day. Bangkok generates 2.6 MCM of wastewater per day. Together with 16 small treatment plants, BMA can treat 1.37 MCM/day or 50% of wastewater. In 2050, it is anticipated that daily wastewater generation in Bangkok will be around 2.47 MCM.

Solid waste in the BMA has two methods of treatment: composting and sanitary landfill. From 2003-2007, the average generation rate excluding the non-registered population was 1.55 kg/capita/day, of which 99% was collecting capacity. In the 6th Bangkok Metropolitan Development Plan (2002–2006), the BMA proposed waste be reduced to less than 1 kg/capita/day, with 15% disposable waste reduction by the end of the plan. Subsequently, the solid waste generation rate was about 1.55 kg/capita/day in 2007 and should decrease to 1 kg/capita/day by 2010. This number should remain constant until 2050. It is projected that in 2050, Bangkok will generate solid waste of 6,718 tons/day.
Figure 2.5-3 Transportation Network in the BMR
Figure 2.5-4 Water Supply and Sanitation System in the BMR
2.5.4 Energy

Thailand has limited domestic petroleum production and reserves, and imports make up a significant proportion of its commercial energy resource requirement. The country also has substantial indigenous deposits of natural gas, but the rate of consumption outstrips the production rate and imports from Myanmar, a neighboring country, make up the shortfall. It also has significant biomass and other renewable resources that are now being increasingly exploited.

Bangkok and Samut Prakan are load centers for energy, especially for petroleum products and electricity. Consumption of fuel oil is used mainly in industry (36%), electricity generation (35%), and transportation (29%). Liquefied petroleum gas is used mainly as cooking fuel in residential and commercial sectors (64%), and smaller proportions are used in agriculture, industry (19%), and transportation (17%). Natural gas is used in power generation (90.3%), industry (9.4%), and transportation (0.4%). Electricity is used in all sectors (Appendix F, page F-3).

Electricity generation to supply the national grid is undertaken mainly by The Electricity Generating Authority of Thailand (EGAT). Distribution of electricity to customers in Bangkok, Samut Prakan, and Nonthaburi is the responsibility of the Metropolitan Electricity Authority (MEA), another state enterprise. Distribution of electricity to the rest of the country is undertaken by the Provincial Electricity Authority (PEA), another state enterprise that also participates in specific small-scale power generation. Both MEA and PEA are under the administration of the Ministry of Interior (MOI). In 2007, the MEA’s network comprised:

1) 17 terminal stations with installed transformer capacity of 15,356 megavolt-amperes (MVA);
2) 134 substations with installed transformer capacity of 15,785 MVA;
3) 230, 115, and 69 kV sub-transmission lines of 1,410 circuit-km; and
4) Total distribution line length of 12,823 circuit-km.

Energy infrastructure in Bangkok and Samut Prakan is shown in Figure 2.5-5.

By 2050, it is assumed that natural gas will become scarce and expensive. It will be increasingly substituted by biomass in applications requiring heat, and by biofuel in applications requiring mechanical power (Appendix F, page F-10). Assuming the capacity of the network to be proportionate to electricity to be supplied due to increased demand, the following lists the number and capacity of facilities required:

1) 38 terminal stations with an installed transformer capacity of 35,660 MVA;
2) 310 substations with an installed transformer capacity of 36,658 MVA;
3) 500, 230, 115, and 69 kV sub-transmission lines of 3,275 circuit-km;
4) Total distribution line length of 29,778 circuit-km; and
5) 10 electric rail lines of 291 km with a substation capacity of 1,964 MVA.
Figure 2.5-5  Energy Infrastructure in Bangkok and Samut Prakarn

Source: The Electricity Generating Authority of Thailand (EGAT), 2008
2.5.5 Public Health

Climate change is projected to bring some mixed effects such as changes in range and transmission potential of malaria in Southeast Asia. Overall, it is expected that impacts will be outweighed by the negative health effects of rising temperatures, especially in developing countries. Critically important will be factors that directly renovate the health of populations such as education, health care, public health initiatives, and infrastructure and economic development.

Higher temperature has been found to be strongly associated with increased episodes of diarrhea disease in adults and children in tropical countries. Associations between monthly temperature and diarrhea episodes have also been reported in Asia and Australia. Although there is evidence that the bimodal seasonal pattern of cholera in Bangladesh is correlated with sea-surface temperatures in the Bay of Bengal and with seasonal plankton abundance (a possible environmental reservoir of the cholera pathogen, *Vibrio cholerae*), winter peaks in disease further inland are not associated with sea-surface temperatures. In many countries, cholera transmission is primarily associated with poor sanitation. The effect of sea-surface temperatures in cholera transmission has been mostly studied in the Bay of Bengal. In Africa, cholera outbreaks are often associated with flood events and fecal contamination of the water supplies.

Following on these trends, it is projected that the population of Bangkok may experience increasing threats of diseases and injury due to extreme weather events. For example, there will be increased burden of diarrheal diseases; increased frequency of cardio-respiratory diseases due to higher concentrations of ground-level ozone in urban areas related to climate change; and the altered spatial distribution of some infectious diseases. Nine contagious diseases related to water rising that should increase are diarrhea, dengue hemorrhagic fever, pneumonia, hand foot and mouth, tuberculosis, hemorrhagic conjunctivitis, typhoid, measles, and leptospirosis. On the contrary, occurrence of cholera may decrease in the long term because the disease would come under control as sanitation improves in Bangkok on pace with socioeconomic development.

2.6 COASTAL ENVIRONMENT

From Samut Sakhon to Samut Prakarn coastal areas, mangrove forests patch along the shoreline and create a channel network that provides an important stock for fishers. It has unfortunately been degraded by both natural and anthropogenic impacts. The mangrove forest along Bang Khun Thian coastline is sited in a zone affected by strong wind and severe wave surges. This condition has caused a high rate of coastal erosion and subsequently damaged the outermost stands of mangrove. Along with land use alteration from natural habitat to shrimp farms, the Bangkok green belt has gradually deteriorated and its buffer function incapacitated. The remaining narrow strip along the coastline is rather poor in species diversity and has less stem density than large-sized stands. The BMA has provided strategies to cease coastal erosion in this zone and rehabilitate mangrove under consultation with local communities and neighboring government agencies.

Figure 2.6-1 Wind Effects on Mangrove in Samut Prakarn
2.7 FLOOD MANAGEMENT


In 1983, the low depression trough across the central plain and two tropical storms passing through the eastern part caused serious flooding problems for Bangkok because of runoff from the east, local rainfall and the high spring tide. After this flood, the government with inspiration from the King’s initiative constructed a 72 km flood protection dike along the inner eastern border of the city. This dike effectively protects inner Bangkok from frequent flooding from the east.

In 1985, there was a sequence of tropical storms from the end of July to early September that caused heavy rainfall in the upper basins and especially the Nan River Basin (450 mm in August) where excess runoff far exceeded the capacity of the Sirikit Dam and 2,900 MCM had to be released. The discharge at Nakhon Sawan reached 4,800 m³/sec. A substantial volume of water was released into the flood plain area between Chai Nat and Ayutthaya province, attenuating the flood discharge into 2,700 m³/sec at Ang Thong province. In October, the peak flood flows coincided with the high spring tide causing very high water levels in the Chao Phraya River. The North, East, and West part of Bangkok were flooded extensively till December in some parts, resulting in heavy economic losses. The inundation depth was between 0.5 to 2.0 m.

Figure 2.7-1 Flood Effect in Ramkhamhaeng University, 1995

Additional flood protection works include the construction of additional storage dams, i.e. the Pasak Dam on the Pasak River, a tributary that has confluence with the Chao Phraya River at Phra Nakhon Sri Ayutthaya, in 1998 and the Khwae Noi Dam on a major tributary of the Nan River in 2008.

In 2006, there was again a very big flood from the northern Chao Phraya River Basin. The rainfall intensity during late September to early October was high, causing the flood discharge at Nakhon Sawan (the confluence of major tributaries of the Chao Phraya River) to be as high as 5,960 m³/sec. Also, runoff from the Pasak River was high even with the storage dam. This large flood spilled over the river dikes and flooded the low lands on both sides of the Chao Phraya River north of Bangkok. The Royal Irrigation Department managed the flood by diverting part of it through canals in the east bank intended for drainage by the Bang Pakong River in the east and also through pumping stations along the eastern coast. In the west, the RID diverted the flood through canals and the Tachin River, which empties into the Gulf of Thailand at Samut Sakhon, thus bypassing Bangkok. Since rainfall in Bangkok itself was not very high, Bangkok and vicinities were saved by their polder and pumping system.