Measuring Urban Water Security

Biologischer Hörsaal, Justus-Liebig-Universität Gießen (JLU), Gießen, Germany
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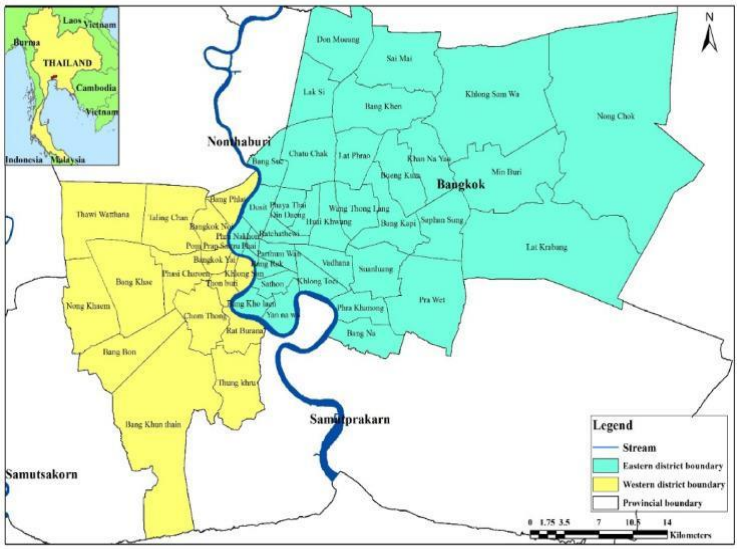
WATSAT HANDS-ON (EXAMPLE)

CITY PROFILE



Bangkok is the capital and most populous city of Thailand. The city covers 1,568.7 km^2 in the Chao Phraya River delta and has an estimated population of 10.5 million as of 2020, 15.3 percent of the country's population.

The city is divided into 50 districts and 154 sub-districts as shown in the adjacent Figure.

Over 14 million people (22.2 percent) lived within the surrounding Bangkok Metropolitan Region as per the 2010 census, making Bangkok an extreme primate city, dwarfing Thailand's other urban centres in both size and importance to the national economy.

The city, incorporated as a special administrative area under the Bangkok Metropolitan Administration in 1972, grew rapidly during the 1960s through the 1980s and now exerts a significant impact on Thailand's politics, economy, education, media and modern society. In 2019, the city had an economic output of 7.16 trillion Baht (US$211.9 billion), contributing 47.5 percent of the gross domestic product (GDP). It is highly commercialized and it's non-agriculture Gross Provincial Product (GPP) is 99.94% of the total GPP. The GPP per capita is among the highest in the region at USD 20,530.

Like most of Thailand, Bangkok has a Tropical Savanna Climate (Aw) under the Köppen climate classification and is influence by the South Asian monsoon system. The average annual rainfall during the period of 1982–2019 was 1672 mm. The city experiences three seasons: hot, rainy, and cool, although temperatures are fairly hot year-round, ranging from an average low of 22.0 °C in December to an average high of 35.4 °C in April. The average annual temperature during the period of 1982–2019 was 28.6 °C.

Bangkok's coastal location makes it particularly vulnerable to rising sea levels due to global warming and climate change. A study by the OECD has estimated that 5.138 million people in Bangkok may be exposed to coastal flooding by 2070, the seventh highest figure among the world's port cities.

WATSAT FRAMEWORK

Dimension	Indicator	Potential Variables	Suggested Way to Measure
WATER SUPPLY AND SANITATION	Water availability	1. Per capita water use (lpcd)	Total domestic water consumption/City population
		2. Number of people using improved water sources (number)	Self-explanatory
		3. Investment in water supply facilities (USD)	Self-explanatory
		4. Percentage of Imported water (%)	Imported water/Total raw water
	Accessibility	1. Population access to piped water supply (%)	[Population of the city with access to piped water supply/City population] x100
		2. Service area coverage for piped water supply (%)	[Area covered by water supply/City area] X 100
		3. Average distance traveled to fetch water from improved water sources (km)	Self-explanatory
		4. Safe drinking water inaccessibility (%)	[Population without access to improved drinking water resources/Total population] x 100
		5. Water supply service duration (h)	Self-explanatory
	Quality of water supplied	1. Customer satisfaction with water quality (1:n)	Number of employees/Number of customers in water utility
		2. Type of water treatment employed (no unit)	Self-explanatory
		3. Coliform count of supplied water (MPN/1000)	E-Coli count
		4. Residual chlorine (%)	Percentage of residual chlorine monitoring points satisfying the remnant requirement
		5. Turbidity of water (NTU)	Self-explanatory
		6. pH of supplied water (no unit)	Self-explanatory
	Hygiene and sanitation	1. Number of people using improved sanitation facilities (number)	[Population of the city with access to improved sanitation/City population] x100
		2. Water borne disease factor (%)	[Hospitalized cases of water borne diseases/Total hospitalized cases] x100
		3. Investment in sanitation facilities (USD)	Self-explanatory
		4. Proportion of population connected to sewer line (%)	[Population of the city connected to sewer system/City population] x100
WATER PRODUCTIVITY	Economic value of water	1. Commercial water productivity (USD/m^3)	Non-agricultural GPP/ Non-agricultural water use in the city
		2. Agricultural water productivity (USD/m^3)	Agricultural GPP/ Agricultural water use in the city
		3. Water wealth (USD/m^3)	Total Income of people/Water used
		4. Water price (USD/m^3)	Self-explanatory
WATER-RELATED DISASTERS	Disaster mitigation	1. Disaster budget factor (%)	[Investment in disaster response mechanisms/ Total city budget] x 100
		2. Per capita GDP (USD)	Total Gross Provincial Product / Total population
		2. Flood damage (USD)	Economic damage caused by floods
		3. Proportional area of flooding (%)	[Flooded area/Total city area] x100

Dimension	Indicator	Potential Variables	Suggested Way to Measure
	Disaster preparedness	1. Natural Drainage factor (%)	[Total open space (green)/ Total city area] x 100
		2. Disaster response mechanism (no unit)	Presence of disaster management plan
		3. Flood risk mapping (no unit)	Presence of flood zoning
WATER ENVIRONMENT	State of natural water bodies	1. Natural water quality factor (%)	[Dissolved Oxygen (DO) concentration/Minimum required standard for DO] x 100
		2. Water Quality Index (no unit)	Country-specific
		3.. Biochemical oxygen demand in water bodies (mg/L)	BOD5 concentration.
	Effect of polluting factors	1. Wastewater treatment factor (%)	[Treated wastewater/Total wastewater generated] x100
		2. Water pollution factor (%)	[Untreated wastewater/ Total wastewater generated] x100
		3. Industrial influent treatment factor (%)	[Treated industrial effluent/Total industrial effluent generated] x 100
WATER GOVERNANCE	Overall management of the water sector	1. Institution factor (no unit)	<u>Questionnaire with water-related agencies</u> 1. Is public opinion sought when developing water-related plans for the city? 2. Is there a provision for the public to register their grievances? 3. Is there an official mechanism to monitor Non-Revenue Water (NRW)? 4. Is there a provision to incentivize judicious water management? 5. Does the organization consult other water organizations during the development of annual or long-term plans?
	Potential to adapt to future changes	1. Adaptability factor (no unit)	<u>Questionnaire with water-related agencies</u> 1. Does recycling and/or reuse of water take place in the city? 2. Is there a centralized database for water related information? 3. Is there a system to forecast water availability and quality? 4. Are future drivers of change (e.g., climate change) taken in consideration when developing long-term city master plans? 5. Is there a mechanism for the organizational staff to upgrade water-related knowledge?

Dimension	Indicator	Potential Variables	Suggested Way to Measure
		2. Proportion of population living in slums (%)	(Slum population of the city /City population) x100
		3. Density of observation stations (%)	[Number of existing rain gauges/Optimal number of rain gauge stations] X 100
	Citizen support for water security	1. Public support factor (no unit)	Questionnaire with water-related agencies 1. Are citizens involved in water management through any mechanisms? 2. Out of the total amount that consumer has to pay as water fees, is at least 80% received every month? 3. Do citizens generally comply with the rules and regulations set for water theft/water malpractices? (generally, may be taken as around 80-90% of the population) 4. Do citizens generally comply with the rules and regulations set for unauthorized groundwater abstraction? (generally, may be taken as around 80-90% of the population) 5. Do citizens generally comply with the rules and regulations set for illegal pollution of water?

EXERCISE DATA SHEET

Year 2017

No.	Data type	Unit	Value
1	City population	persons	9,005,378
2	Population with access to piped water supply	persons	8,213,805
3	City area	km^2	1565.2
4	Green areas (open space)	km^2	378
5	Commercial GPP	USD/year	129,481,385,699
6	Total city budget	USD/year	15,068,000,000
7	Total water supplied in the city	MCM/year	1,835
8	Amount of Imported water	MCM/year	511
9	Number of residual chlorine monitoring points satisfying the remnant requirement	Number	26
10	Number of residual chlorine monitoring points	Number	28
11	Total domestic water consumption	Cubic meters/year	474,100,000
12	Commercial water use in the city	Cubic meters/year	392,310,000
13	Hospitalized cases of water borne diseases	Number	38,227
14	Total cases of hospitalization	Number	3,744,546
15	Investment in disaster response mechanisms	USD	451,465,800
16	Average Dissolved Oxygen (DO) concentration at all monitored locations	mg/L	1.74
17	Minimum required standard for Dissolved Oxygen (DO)	mg/L	2
18	Volume of wastewater that is treated	Cubic meters/day	1,106,013
19	Volume of wastewater that is generated	Cubic meters/day	1,898,981
20	Is public opinion sought when developing water-related plans for the city?		Yes
	Is there a provision for the public to register their grievance?		Yes
	Is there an official mechanism to monitor Non-Revenue Water (NRW)?		Yes
	Is there a provision to incentivize judicious water management?		Yes
	Does the organization consult other water organizations during the development of annual or long- term plans?		Yes
	Does recycling and/or reuse of water take place in the city?		No
	Is there a centralized database for water related information?		Yes
	Is there a system to forecast water availability and quality?		Yes
	Are future drivers of change (e.g., climate change) taken in consideration when developing long term city master plans?		Yes
	Is there a mechanism for the organizational staff to upgrade water-related knowledge?		Yes
	Are citizens involved in water management through any mechanisms?		Yes
	Out of the total amount that consumer has to pay as water fees, is at least 80% received every month?		Yes
	Do citizens generally comply with the rules and regulations set for water theft/ water malpractices? (generally, may be taken as around 80-90% of the population)		Yes
	Do citizens generally comply with the rules and regulations set for unauthorized groundwater abstraction? (generally, may be taken as around 80-90% of the population)		No
	Do citizens generally comply with the rules and regulations set for illegal pollution of water? (generally, may be taken as around 80-90% of the population)		No