



BANGKOK THAILAND

2022 Exploring Urban Resilience Pathways



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About the report and the collection

Exploring Urban Resilience Pathways

This report is part of a collection wishing to provide a global overview about different cities' experience in resilience, and how this is evolving. The series is titled "Exploring Urban Resilience Pathways" and each report is prepared by one student of the Int. MSc. in City Resilience Design and Management (URNet-UIC Barcelona). During the first semester, students develop these reports as a learning outcome for their acquired analytical skills: to find, understand, organize and communicate critically different perspectives, approaches and models of urban resilience implementation, in a chosen city.

The aim of each report is thus to offer an easy-to-read overview about how adaptive capacities have been evolving in a selected city. The reports explore the past and current mechanisms through which each city responded to overlapping shocks and stresses. Nowadays current City Resilience Strategies – launched and supported by the Rockefeller 100RC program – are included within these analyses, representing the ultimate trend of understanding and implementing city resilience. Finally, current COVID19 pandemic responses are the final lens through which resilience mechanisms are discussed, to understand the alignment of resilience with other key urban goals, and ultimately respect to urban living.

What is interesting to learn from this series of reports, is that each of them critically discusses how cities managed adaptive responses to different treats, and how the concept of resilience evolved. Although the scope of these reports is ambitious and the analysis could result complex, the presentation has been designed to be easy to read and accessible to the general public. Each report of this collection maintains a standard structure, facilitating the reading and the reports (and cities) comparison.

Hope this initiative contributes to spread the understanding about how resilience has been framed and implemented in many cities across the globe.

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Director of the International Msc. in City Resilience Design and Management

BANGKOK THAILAND

2022 Exploring Urban Resilience Pathways

SUMMARY

Bangkok is located in the Kingdom of Thailand's capital city, and one of the world's megacities. In this report Bangkok stands for the City of Bangkok, a municipality and province part of the Bangkok Metropolitan Region (BMR) that counts five other provinces. The City of Bangkok is administered by the Bangkok Metropolitan Area (BMA). Located in the Delta area of the Chao Phraya River basin, the city is on low lying coastal zone, covering about 35% of the total land area.

In 2007, the BMA designed the first climate plan to reduce GHG emissions by at least 15% compared to levels at the time. This was followed by the Bangkok Master Plan on Climate Change in 2013 with four key areas: transport, energy, waste and planning. Parallel to this, the city joined the 100 Resilient Cities movement and created 'Resilient Bangkok' plan to respond to the many stresses and shocks the city experiences. The BMA also developed Bangkok 2020 and Bangkok 2032 for an overall vision for a vibrant city.

The main risk reduction approach for flood risk by the central government and BMA is to implement physical, hard engineering solutions with structural measures such as flood barrier, pumping station or drainage tunnels.

The three key action areas the government focuses on in all plans are about *increasing quality of life; reducing disaster risk and increasing adaptation to natural hazards; driving a strong and competitive economy*. Better understanding of the importance of nature-based solutions is necessary, along with financial resilience and creating awareness at different levels.

Central and local governments need to come together and cooperate to face Bangkok's challenges and create a vision that encompasses resilience and nature-based solutions as priority, to prevent the city from being flooded by 2030.

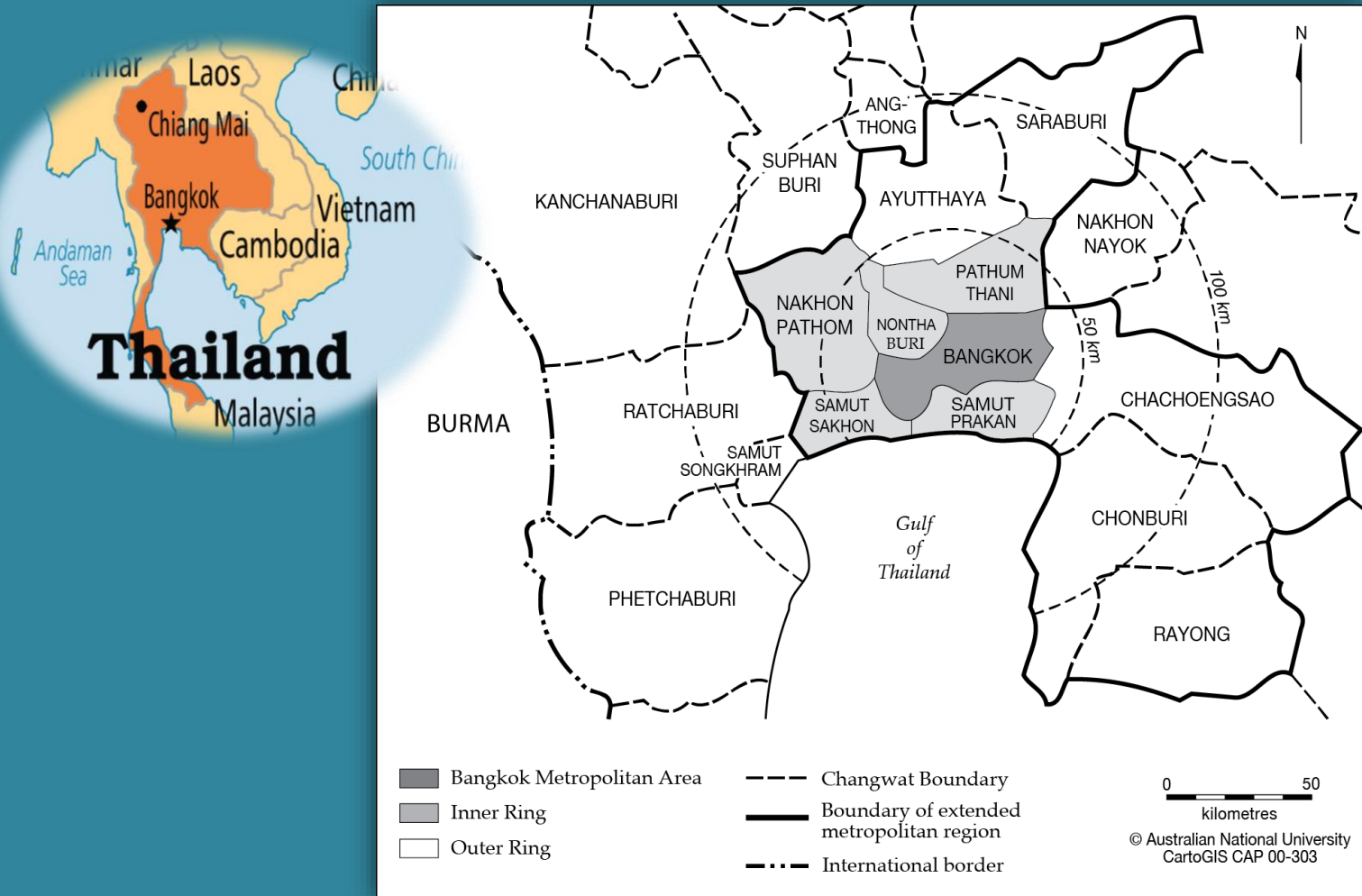


Fig. 1 BMA, BMR, and surrounding context (Source: ANU College of Asia & the Pacific)



Fig. 2 Aerial view of the City of Bangkok (Source: Getty Images)

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LIST OF ABBREVIATIONS

100 RC	100 Resilient Cities
BMA	Bangkok Metropolitan Area
BMR	Bangkok Metropolitan Region
CRO	Chief Resilience Officer
NESDP	National Economic and Social Development Plan
OECD	Organisation for Economic Co-operation and Development
CODI	Community Organisations Development Institute

INTRODUCTION

BANGKOK

The Kingdom of Thailand, is ruled by a unitary government and a constitutional monarchy since 1932, modelled after the Westminster ruling system. Since then, coups d'état had the military leads the country at several times, including in 2014 when the National Council for Peace and Order came to power and exerted control over opponents to the regime. All branches of governments and economic activities are concentrated in the City of Bangkok, the capital and primary city of Thailand. Bangkok is roughly thirty-five times larger than Thailand's second largest city Chiang Mai.

Thailand is divided into 76 regions called Provinces. It is the Ministry of the Interior who appoints governors for all provinces. Only the City of Bangkok can choose its own governor as elected by the residents. The Bangkok Metropolitan Region (BMR) includes the City of Bangkok, municipality, and province, and five other provinces: Samut Sakhon, Samut Prakarn, Nonthaburi, Pathum Thani and Nakhon Pathom.

In 2022, close to 11 million residents live in the City of Bangkok within 1,500 km². Between 2000 and 2020, the city centre's population grew by 30%, while suburban provinces grew by 66%. The urban growth was so rapid that the government and local organizations had limited time to foresee the numerous environmental, economic and social challenges that the city would face, and to adapt existing plans and long-time focus on economic growth to create a more inclusive and sustainable metropolis.

The City of Bangkok has the advantages of being a coastal city and "first-mover agglomeration economy". Between 1997 and 2007, the city of Bangkok experienced an important decrease in manufacturing and agricultural activities in favour of services, including real estate, accounting, consultancy, architectural services.

Bangkok has faced continuous urban sprawl, fractioned transport system, flooding risk, political unrest and other significant disruptions amidst increasing inequality and rampant urbanization. The 'Resilient Bangkok' Plan is an important step forward for the city and mark a shift of thinking at government level.

Nowadays Bangkok is still subject to many challenges. One is its topographical location. Floods in 2011 were a major event as resulted in USD 47 billion worth damage. The land is sinking, storms, extreme temperatures and flooding are more likely due to the tropical climate and are becoming more frequent with climate change. Besides Bangkok is a place of inequalities, with about 30% of Bangkok's inhabitants live in slums. Access to economic opportunities is unequal. Pollutions levels are high.

National and local plans and strategies will help tackle these challenges, meanwhile bottom-up community and private initiatives will be necessary to achieve resilience for Bangkok.



Fig. 3 Aerial view of Bangkok showing the contrast between the old and new city (by William Perugini)

Bangkok's international ambitions and challenges

"Only by preparing Bangkokians, our communities, institutions, businesses and systems to survive, adapt and grow no matter what kind of chronic stresses and acute shocks we experience, can we bring our city closer to our vision of a city that is safe, liveable and sustainable for all. We must work to improve social services and mobility for all residents. We must ensure no one is left behind, for to be successful, we must lift everyone up."

(Dr. Supachai Tantikom, Bangkok's CRO)



Coastal city

Bangkok is located in a low-lying coastal zone that is subject to subsidence. There are numerous canals crossing streets in the centre along with the Chao Phraya River. The city is at high risk of flooding.



Congested city

The transport system design fosters vertical segregation and endless traffic. Several areas of the city do not have access to public transport. Mass transit system is primarily designed for cars.



Growing city

The city of Bangkok population has increased by about 65% in two decades, since 2020, and the city continues expanding. Daytime population close to 15 million, as people commuting from other provinces to work.

CITY PAST

ADAPTIVE PATHWAY

This section explores the development of the City of Bangkok prior to *Resilient Bangkok* that was launched in 2017.

Six key challenges are reviewed in detail, while stresses and shocks the city experiences are related to BMA's response in terms of plans and strategies over the years (Table 2).

Introduction

Bangkok became the capital of Thailand in the 18th century. First a small village built around the Chao Phraya River, the 20th century was a time of rapid urbanization and exponential growth for Bangkok. The expansion led to become Thailand's primary city (about thirty-five times larger than Chang Mai) brought numerous challenges to the city and its inhabitants. Vulnerabilities include stresses such as fragmented and car centric transport system, rapid urbanisation, growing social inequality, unsustainable economic growth, climate change, GHG emissions, energy consumption, high flood risk, water management, drought, air pollution, noise pollution, water quality, land subsidence.

This section of the report focuses on some key challenges of the 20th century for the City of Bangkok: economic and population growth, land use, transport, land subsidence and high flood risk.

In terms of shocks, three major events occurred for the City of Bangkok in the past 30 years: the 1997 Asian Financial Crisis, the 2008 Global Financial Crisis, and the 2011 Monsoon Floods, which helped shape the following plans and strategies to make Bangkok more resilient.

Prior to 'Resilient Bangkok' plan (published in 2017), several documents were put forward to improve the quality of life of inhabitants and foster economic growth and environmental security. Table 2 summarises plans and strategies since 1961 and put them in relation with shocks and stresses – see Page 18.

Governance & Economic Growth

Thanks to its strategic geological location, rapid urbanisation and industrialisation, and tourism revenues, Bangkok became Thailand's primary and megacity, with major financial groups, governments institutions, administrations and headquarters located in the city centre. The city of Bangkok accounts for approximately 30% of Thailand's GDP.

Since the 1960s, the **National Social and Economic Development Plans (NESDP)** serve as general guidelines for policy makers and government agencies across Thailand. The first NESDP mostly promoted economic development of the Bangkok Metropolitan Region (BMR). The 10th NESDP was the first plan to cover the three dimensions of sustainable development, with the vision to create "green and happy society".

Thailand's governance system is very centralised and local municipalities have little influence over planning policies. Most decisions are taken by the central government bodies in all sectors, political, economic, social, environmental, industrial, administrative. This means developed plans are not specific to the local area and it is difficult to apply their principles without adapting policies to the studied area.

In 1997, the same year as the Asian financial crisis, the Thailand government established the **1997 Decentralised Action Plan** to delegate authority to local governments such as the Bangkok Metropolitan Area (BMA). Each local government was able to draft their own Comprehensive Plan. The BMA received control over policies for the areas of land use, wastewater treatment, solid waste management (OECD, 2015).

	City of Bangkok	Nakhon Pathom Province	Nonthaburi Province	Pathum Thani Province	Samut Prakan Province	Samut Sakhon Province
Registered population (2013)	5 686 252	882 184	1 156 271	1 053 158	1 241 610	519 457
Number of districts <i>amphoe/khet</i>	50	7	6	7	6	3
Number of sub-districts <i>tambon/khwaeng</i>	169	105	52	60	50	40
Number of municipalities	1	19	17	27	18	12
– Cities (<i>thetsaban nakhon</i>)	1	1 (Nakhon Pathom)	2 (Nonthaburi and Pak Kret)	1 (Rangsit)	1 (Samut Prakan)	2 (Samut Sakhon, Om Noi)
– Towns (<i>thetsaban mueang</i>)	–	4	4	9	4	1
– Sub-district municipality <i>(thetsaban tambon)</i>	–	18	11	17	13	9

Source: Department of Local Administration, www.dla.go.th/en/s2.jsp (last accessed 16 January 2015).

Table 1. Local administrative system in the Bangkok Metropolitan Region (BMR). OECD, 2015.

Population growth

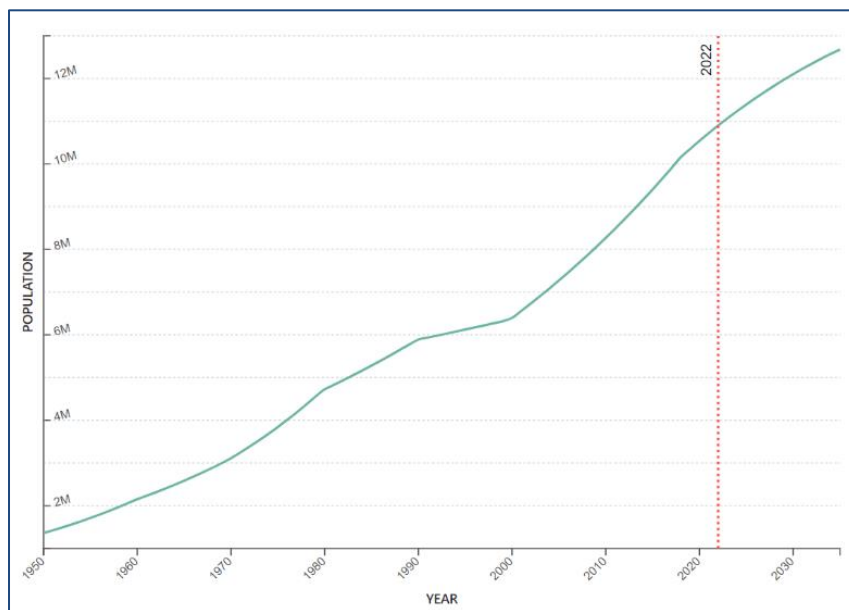
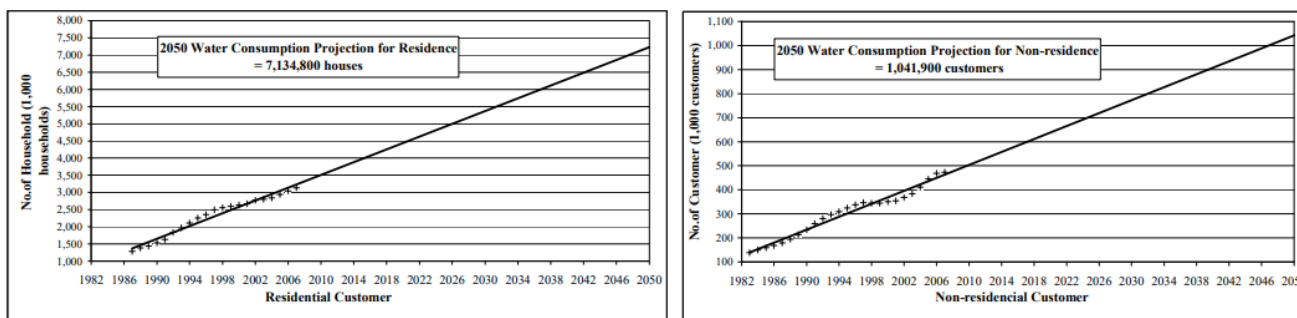


Fig. 4 Bangkok Population in 2022, estimated at 10,899,698 (Source: World Population Review)

Exponential population growth leads to urban sprawl and chaotic organization. Much of the daytime population in the City of Bangkok commutes from other districts, bringing the total population from about 10 to 15 million (2010). Today approximately 10.9 million people living in the City of Bangkok only.

This population growth leads to significant environmental and social stresses, including lack of housing, poor water and waste management, diseases. In 2009, Panya Consultants determined water demand future trend based on data recorded between 1983 and 2007, for non-residential and residential users. This showed the linear growth of water demand with the years, demonstrating the need for improvement of the water system (potable water access, pipes system, water management and treatment).



Source: Panya Consultants' calculation

Fig. 5 Water Demand Projection for Bangkok and Samut Prakarn, based on 1983-2007 data (Source: Climate Change Impact and Adaptation Study for BMR, Panya Consultants, 2009)

Land Use

The urban growth of the City of Bangkok started along the river to the estuary, and hundreds of canals ('khlongs' in Thai) in the delta of Chao Praya, later expanded along transport lines and smaller cities on the outskirts. At the end of the 19th century, some canals were recovered by roads, while others used as way of transportation and floating markets, as it is still the case today. Industries, malls, and housing developments rapidly replaced farms lands and rice fields in the 20th century. The urbanisation in the vicinities of the BMR led to the disappearance of natural areas of water retention (swamps, wetlands) and natural flood ways. Mangroves were cut down at rapid rate and affected by coastal erosion (WWF, 2009), OECD.

Today the BMR is the biggest urban agglomeration in Thailand.

The figure below illustrated the significant change in land use and land cover since the 1980s: agriculture LULC decreased by approximately 44%. The maps comparison also shows the City of Bangkok becoming predominantly urban within 13 years.

The **National Spatial Development Policy Plan**, established in 2007, aims to respond to this challenge of uncontrolled land distributions.

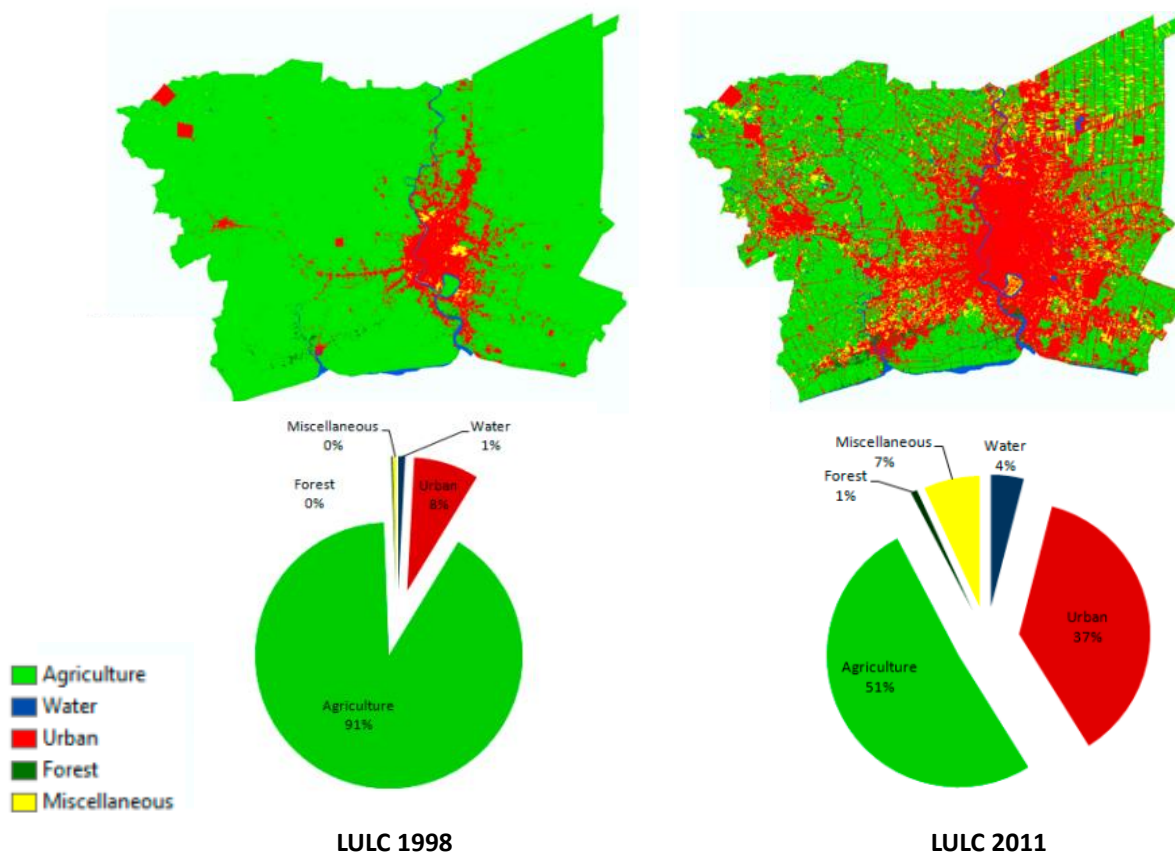


Fig. 6 Land Use and Land Cover (LULC) classifications using satellite images (Source: 'Modeling Urban Expansion in Bangkok Metropolitan Region Using Demographic–Economic Data through Cellular Automata-Markov Chain and Multi-Layer Perceptron-Markov Chain Models' 2016)

A fragmented and car-centric transport system

Bangkok is the **world's second most congested city** (Global Future Cities) due to competing and fragmented modes of transport. The city centre is very dense, with large avenues at 4 to 8 lanes forming a Damier pattern. Arteries are very difficult to cross and dangerous for pedestrians, as there are no sidewalks.

The city is in constant construction to extend the transport lines to the outskirts. There are only two underground lines and an aged bus network. The BMA aims for its inhabitants to use public transport, but the system is car-centric, and more highways and expressways networks are being built, favouring two- and four-wheels modes of transport.

The urban transport challenges first appeared in the mid-1950s due to the lack of capacity of the transport network not sustaining the continuous growth of Bangkok. In response to this, the central government prepared the first urban planning master plan in 1960. In 1975, the first comprehensive transport planning study was undertaken, and proposed a **mass transit system** in Bangkok.

Though this helps to provide a network for the steadily growing population, the following challenges still need to be addressed:

- Vertical segregation of the road network. This is created by the tolled motorways built on concrete stilts, which are used to access the “upper part” of the city.
- Air and noise pollution due to a network designed primarily for cars
- Concrete and asphalt infrastructures increasing urban heat island effect
- Design not adapted to pedestrians: activities and tropical climate make it difficult and dangerous for people to walk by.

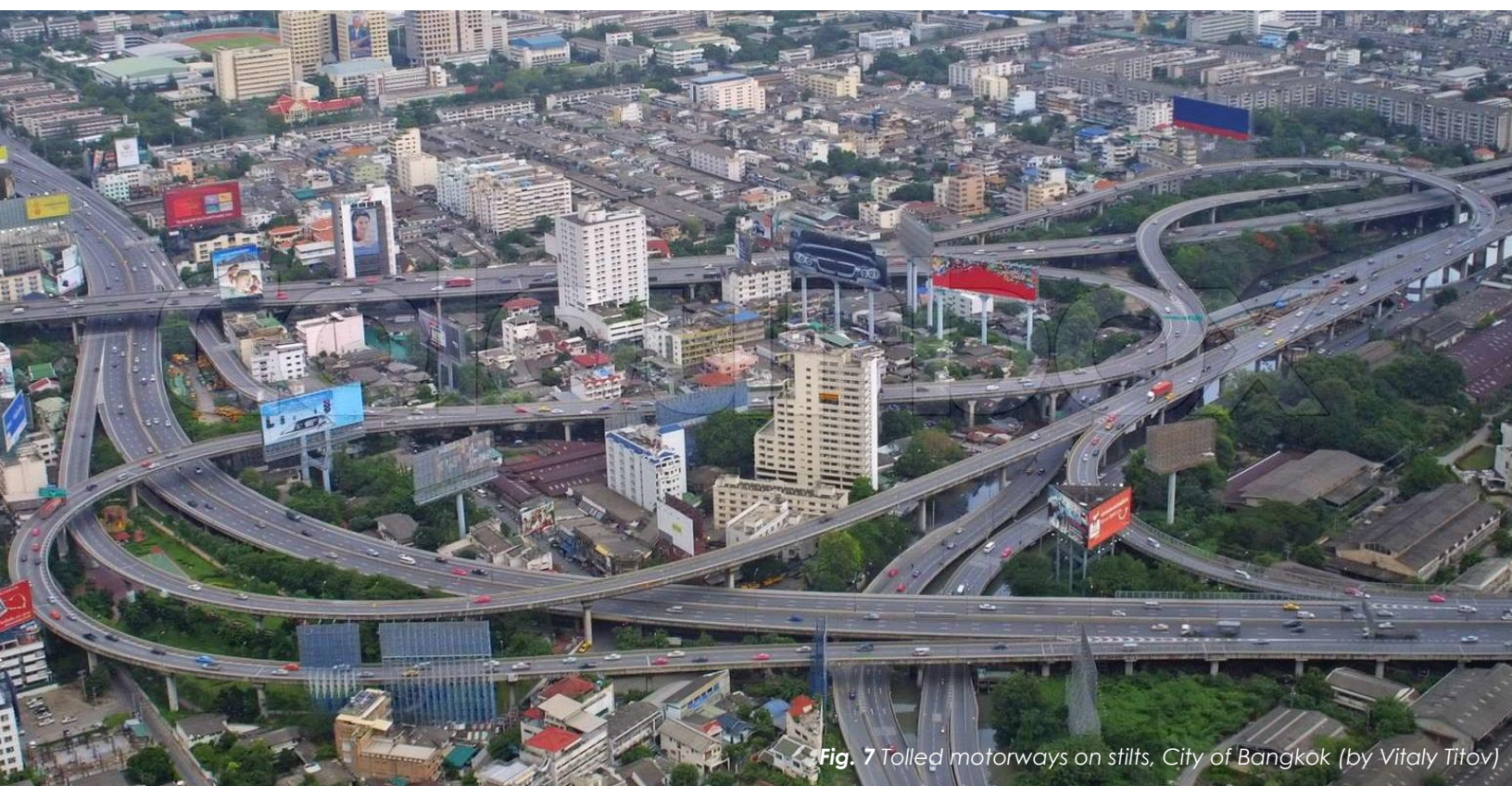


Fig. 7 Tolled motorways on stilts, City of Bangkok (by Vitaly Titov)

Land subsidence and high risk of flooding

Bangkok is a coastal city, between 0.5 and 1.5m above sea level. Its location makes the city vulnerable to rising sea level, storms, and heavy rainfalls. The city is frequently inundated with severe flooding during the rainy season, which is exacerbated by the rapid urbanisation and high percentage of hardstanding areas that cannot manage the runoff.

Built on clay, the city is subject to a phenomenon called “subsidence” and is sinking by about 1-3cms per year, according to diverse estimates.

Land subsidence is due to rapid, heavy construction, groundwater pumping, and rising sea levels (National Reform Council panel warning). In 2019, the City of Bangkok accounts for about 140 skyscrapers of more than 150m high and 700 buildings of more than 20 storeys (CNES).

Shocks like flood, building collapse are likely with accelerated subsidence. Areas of the city at 0.5mAOD are at high risk of flooding.

Since 1983, the central government, BMR and BMA work together on improving flood resilience and protection infrastructure. Two key systems are considered:

- Dikes to prevent water discharge from tides and overflows from urban waterways.
- Drainage system with pumping stations and water gates, drainage pipes and tunnels to direct runoff towards the sea, storm retention ponds.

In 2010, the **National Disaster Prevention and Mitigation Plan** (2010-2014) was established to protect the city against floods.

Following the deadly floods of 2011, the government invested in a project of 500 billion BAHT to further protect the city using **physical, hard engineering barriers** such as diversion tunnels, drainage tunnels, additional retention ponds and water expressways to drive overflow to the sea or to diversion tunnels.

BANGKOK SINKING

Between sea-level rise and land subsidence

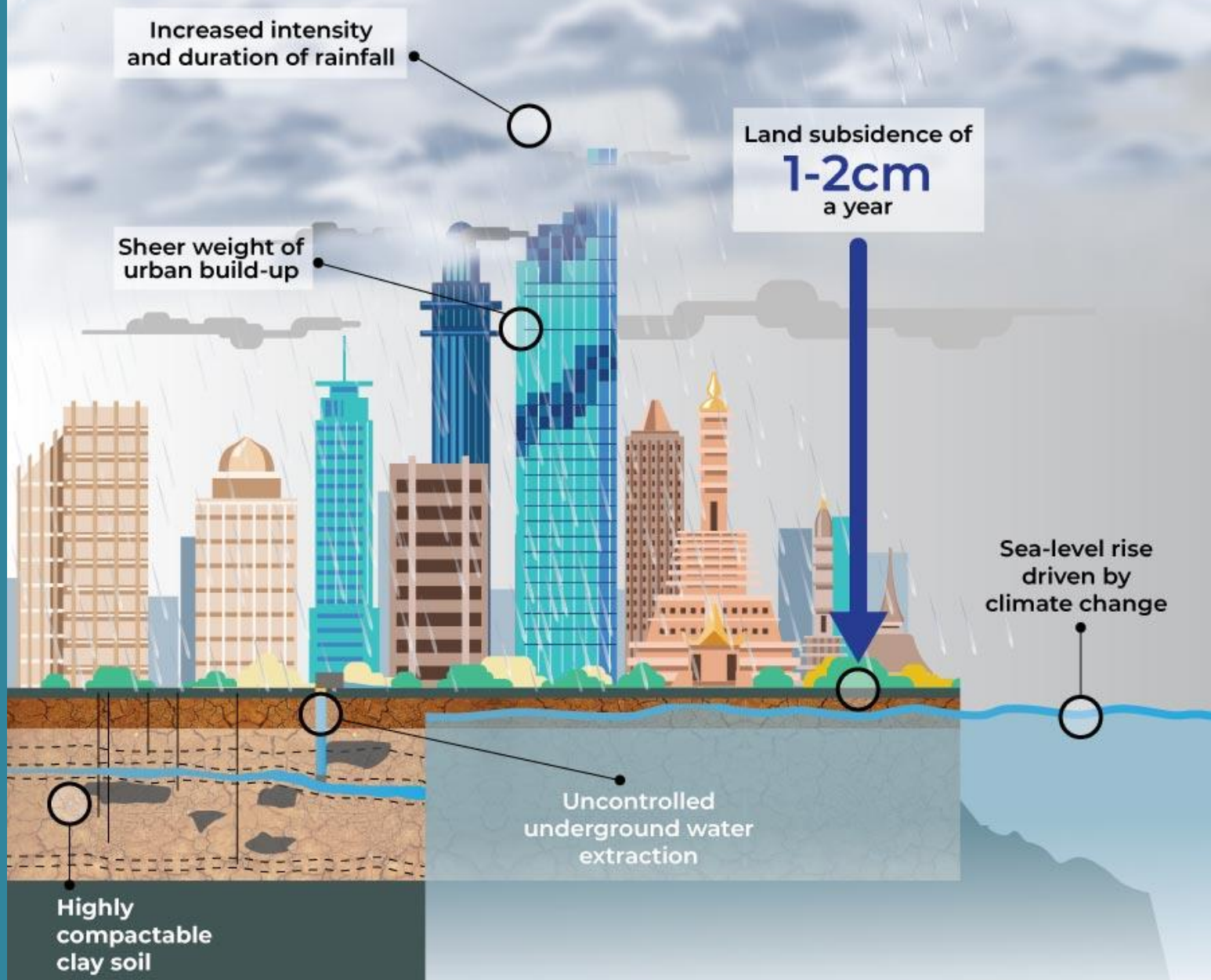


Fig. 8 Bangkok Sinking - Land subsidence explained (Source: The ASEAN Post, Sept. 2018)

Poverty and social inclusion

With almost one quarter of Bangkok's population living in slums, the city faces many social challenges including social inequity, inequality, poverty, unemployment, unsanitary living conditions. Many of Bangkok inhabitants are informal workers and are subject to poor working conditions.

These challenges represent an obstacle for labour productivity and economic development, which is why the central government works to improve living conditions for all in its **NESDP** plans.

The case of Baan Mankong program

in the 1990s, a first initiative for community-based development was to open the Urban Community Development Office for people to decide about housing projects. This was prior to the Community Organisations Development Institute (CODI).

In 2003, the central government granted a budget of \$90 million for slum upgrading and \$130 million for housing loans for the Baan Mankong program.

The community-oriented Baan Mankong program for low-income city dwellers would help address poverty and social inclusion challenges. Designed for resident-led community groups, projects can be prioritised by the community and unsanitary spaces converted into durable and healthy homes. Building can be upgraded along with the quality of life. In 2015 the program reached 100,000 households.



Fig. 9 Slums – Bangkok (Source: Getty Images/iStock)

Sector	National	Provincial/Local	Respond to stresses ❖ and shocks ☐
Social Development	<ul style="list-style-type: none"> Baan Mankong Program 2003 National Economic & Social Development Plan - every 5 year (since 1972) 11th NESDP (2012-2016) 		<ul style="list-style-type: none"> ❖ Reduce chronic diseases ❖ Access to healthcare & minimum standards of living ❖ Lack of education/skills ❖ Unemployment ❖ Ageing population ❖ Inequity ☐ Emergency situations ☐ Social unrest ☐ Collapse of housing market ☐ Terrorism
Economic Development	<ul style="list-style-type: none"> First Economic Development Plan (1961) National Economic & Social Development Plan - every 5 year. 11th NESDP (2012-2016) 	<ul style="list-style-type: none"> Bangkok Development Plan (Bangkok 2020) Bangkok 2032 	<ul style="list-style-type: none"> ❖ Economic downturn ❖ Unemployment ❖ Lack of education/skills ❖ Lack of safety for tourists ❖ Inequity (slums) ☐ Economic crisis
Climate Change	<ul style="list-style-type: none"> National Strategy on Climate Change (2008-2012) National Strategy on Climate Change (2013-2017) Thailand Climate Change Master Plan (2012-2050) 11th NESDP (2012-2016) 	<ul style="list-style-type: none"> BMA Action Plan on Global Warming Mitigation (2007-2012) Bangkok Master Plan on Climate Change (2013-2023) 	<ul style="list-style-type: none"> ❖ Climate change consequences (heat waves, high precipitations) ❖ Lack of green space ❖ High GHG emissions ❖ Inequity ❖ Environmental degradation ☐ Flood ☐ Earthquake ☐ Fire ☐ Heatwaves ☐ Drought ☐ Infection disease
Environmental Quality	<ul style="list-style-type: none"> Environmental Quality Management Plan (2007-2011) 	<ul style="list-style-type: none"> Bangkok Air Quality and Noise Management Action Plan (2012-2016) 	<ul style="list-style-type: none"> ❖ Air Pollution ❖ Noise Pollution ❖ Reduce chronic diseases
Land Use/Transport	<ul style="list-style-type: none"> Baan Mankong Program 2003 National Spatial Development Policy Plan (2007-2057) 2013 Bangkok and Vicinities Development Structure Plan (a BMR-wide plan run by the central government) 	<ul style="list-style-type: none"> Bangkok Comprehensive Plans (1992, 1999, 2006, 2013) Bangkok's Mass Transit Development Plans (started in 1994, every 5 year) 	<ul style="list-style-type: none"> ❖ Traffic congestion ❖ Air Pollution ❖ Agriculture areas decreasing ❖ Urban sprawl ☐ Traffic accidents ☐ Famine ☐ Building/Infrastructure collapse
Energy	<ul style="list-style-type: none"> Energy conservation plan 20-year Energy Efficiency Development Plan (2011-2030) 10-year Alternative Energy Development Plan (2012-2021) 	<ul style="list-style-type: none"> Bangkok Master Plan on Climate Change (2013-2023) 	<ul style="list-style-type: none"> ❖ High GHG emissions ❖ Air pollution ❖ Energy waste ❖ Inequity (access to heating/cooling/electricity) ☐ Power outages
Water and Solid Waste management	<ul style="list-style-type: none"> National Roadmap of Solid Waste Management Plan (2015-2019) 	<ul style="list-style-type: none"> 20 year Bangkok Solid Waste Management Plan (2007-2026) Master Plan on Sewage Sludge Treatment/Disposal and Reclaimed Wastewater Reuse in Bangkok (1999-2020) Preparatory Survey for Bangkok Wastewater Treatment Project in Thailand: Conception Master Plan (2011-2040) 	<ul style="list-style-type: none"> ❖ Environmental degradation ❖ Poor waste and water management ❖ Encroachment of canals ❖ Vulnerable conditions for the poor ❖ Health problems/reduce chronic diseases ❖ Groundwater pumping ☐ Infectious disease/public health issues ☐ Building/Infrastructure collapse ☐ Water crisis (e.g. Cape Town)
Resilience	<ul style="list-style-type: none"> National Disaster Prevention and Mitigation Plan NDPMP (2010-2014) 11th NESDP (2012-2016) 	<ul style="list-style-type: none"> Bangkok Disaster and Prevention Management Plan (2010-2014) 	<ul style="list-style-type: none"> ☐ Flood ☐ Earthquake ☐ Fire ☐ Heatwaves ☐ Drought ☐ Building/infrastructure collapse ☐ Infectious disease pandemic ☐ Other emergency situations

Table 2. Plans and strategies related to resilience prior to „Resilient Bangkok ‘, at national and local level, in relation with key shocks and stresses. By Author, adapted from OECD (2014).

NOWADAYS URBAN RESILIENCE

Nowadays, following the *Resilient Bangkok* resilient plan's publication, the central and local governments focus on the most pressing challenges: transport, flood, creation of green spaces, energy. This section reviews current plans and highlights public and private initiatives that proved effective to make Bangkok more resilient.

Key plans and strategies (national and local)

NESDP

The first National Economic and Social Development Plan was established in 1961, for a framework for sustainable development in the country. Only the **11th NESDP** (2012-2016) mentioned resilience for the first time, with the vision of a “happy society with equity, fairness and resilience”, and four missions:

1. Fair and peaceful society
2. Increase the potential of all Thais (holistic approach)
3. Develop an efficient and sustainable economy by upgrading production and services based on technology, innovation, and creativity and by upgrading eco-friendly production and consumption toward low-carbon society
4. “Build secure natural resource and environmental bases through supporting community participation and improve resilience that will “cushion” the impact of climate change and disasters.” (from NESDP, 2011).

For the **12th NESDP (2017-2021)**, the Office of the National Economic and Social Development Board (NESDB) adhered to the **20-year National Strategy** framework (2017-2036), the country's Sustainable Development Goals (SDGs), and the Thailand 4.0 Policy. The Twelfth Plan shares the vision of the 20-year National Strategy, which is “Thailand as a developed country with security, prosperity, and sustainability in accordance with the principles of the Sufficiency Economy Philosophy”. The targets and indicators of the Twelfth Plan have been set according to the targets of the 2017-2036 National Strategy, and are also in line with the economic, social, and environmental objectives which have been developed by the international organizations, such as Sustainable Development Goals (SDGs).

The **13th NESDP** (2023-2027) is due to be published soon. In September 2021, the Thai Prime Minister shared on Facebook the five goals to transform the nation as part of the 13th NESDP. The five strategic areas are as follows:

1. Restructuring of production, into an economy based on innovation that aligns with technology trends and global trade
2. Developing people/human resources to have the ability and quality of life suitable for the new world
3. Creating a society of opportunity and fairness
4. Creating sustainability for the country
5. Preparing the country to cope with risks and changes in a new global context

This plan outlines focus on innovation, education and aims to reduce social inequality, develop transportation infrastructure throughout the country like previous plans, reduce environmental problems and “upgrade government services with digital systems”. This shows the government is focused on creating innovative, smart cities and developing further transportation network, encouraging growth as it has done for the past decades. There is no specific mention of resilience or climate change impact.

Bangkok Master Plan on Climate Change

Global warming due to GHG emissions increased the frequency of extreme events such as flood and droughts over the 20th century and start of 21st. The City of Bangkok gets flooded roughly every 2-3 years. To counter effects of climate change, the BMA decided to design the *Bangkok Master Plan on Climate Change 2013–2023* with a focus on mitigation.

This master plan builds on the *Bangkok Action Plan on Global Warming Mitigation 2007-2012*, first climate change plan of the BMA, to reduce GHG emissions by at least 15% compared to levels at the time.

C40 cities reported that though many local projects addressing climate change were started, challenges linked to implementation arose.

These projects included the mass transit rail system expansion within the BMA, promote the use of renewable energy, improve building electricity consumption efficiency, improve solid waste management and wastewater treatment efficiency and to expand park area, as highlighted in the table below.

Table 3 shows that the Action Plan targets were achieved for four out of five initiatives. The transport system initiative target for CO₂ emissions reduction was five times lower than the target, therefore the new masterplan on Climate Change will aim to improve this sector in priority – while balancing with the objectives of infrastructure development of the NESDP.

A new plan was under review in 2019 (C40 Cities).

Initiative	Action Plan	Target reduction of CO ₂ in 2012 (million tonnes)	Total amount of CO ₂ reduction (million tonnes)
1. Expand mass transit and improve the traffic system	1. Expand the mass transit rail system within the Bangkok Metropolitan Area 2. Improve the public bus system 3. Improve the traffic system	5.53	1.01
2. Promote the use of renewable energy	1. Promote the use of biofuels	0.61	0.88
3. Improve building electricity consumption efficiency	1. Improve building energy consumption efficiency 2. Electricity conservation campaign	2.25	2.70
4. Improve solid waste management and wastewater treatment efficiency	1. Increase efficiency in solid waste management 2. Increase efficiency in wastewater treatment	0.46	0.70
5. Expand park area	1. Plant trees in the Bangkok Metropolitan Area 2. Plant trees in the neighbouring provinces	0.90	1.69
Total		9.75 (20% below business as usual)	6.98 (14.3% below business as usual)

Source: BMA (2013a), "Low-carbon society development in Bangkok", Bangkok Metropolitan Administration, Bangkok.

Table 3. Targeted and actual reduction of CO₂ emission through the Bangkok Action Plan on Global Warming Mitigation 2007-2012 (Source: OECD, 2015)

The BMA will set a new mitigation target for 2030 for its climate change actions in order to fill the gap between the current target under the Master Plan 2020, and consistent with the implementation under the Paris Agreement as well as Thailand's NDC.

Bangkok 2032 (2013-2032)

The 20 Years Development Plan has an ambitious vision for Bangkok as "one of the world's leading cities, with a stable and growing economy, and a safe, beautiful, environmentally friendly city".

The development will roll out in 4 phases:

1. 2013-2017: become a safe and democratic city
2. 2018-2022: become a green, comfortable city and a city of all, elderly, disabled and the poor
3. 2023-2027: undergo a physical reform from a single centre city to a multi-centre city with a well-functioning infrastructure and an efficient transportation system
4. 2028-2032: become an economic and financial centre. And centre of education, investment, culture

It is interesting to notice that the plan unfolds in temporal phases with one specific sector for each. Though the plan mentions the need for a green and inclusive city (Phase 2), Phase 4 is focused on economic growth, as it was in the 20th century.

As climate change effects will become more extreme and frequent, it would be necessary that the government develops each sector throughout the next 20 years of the plan.

Resilient Bangkok (2017)

The plan acknowledges the key challenges that the City of Bangkok must face due to rapid urbanisation and climate change.

The vision, strategic action areas and goals are presented in the figure below.

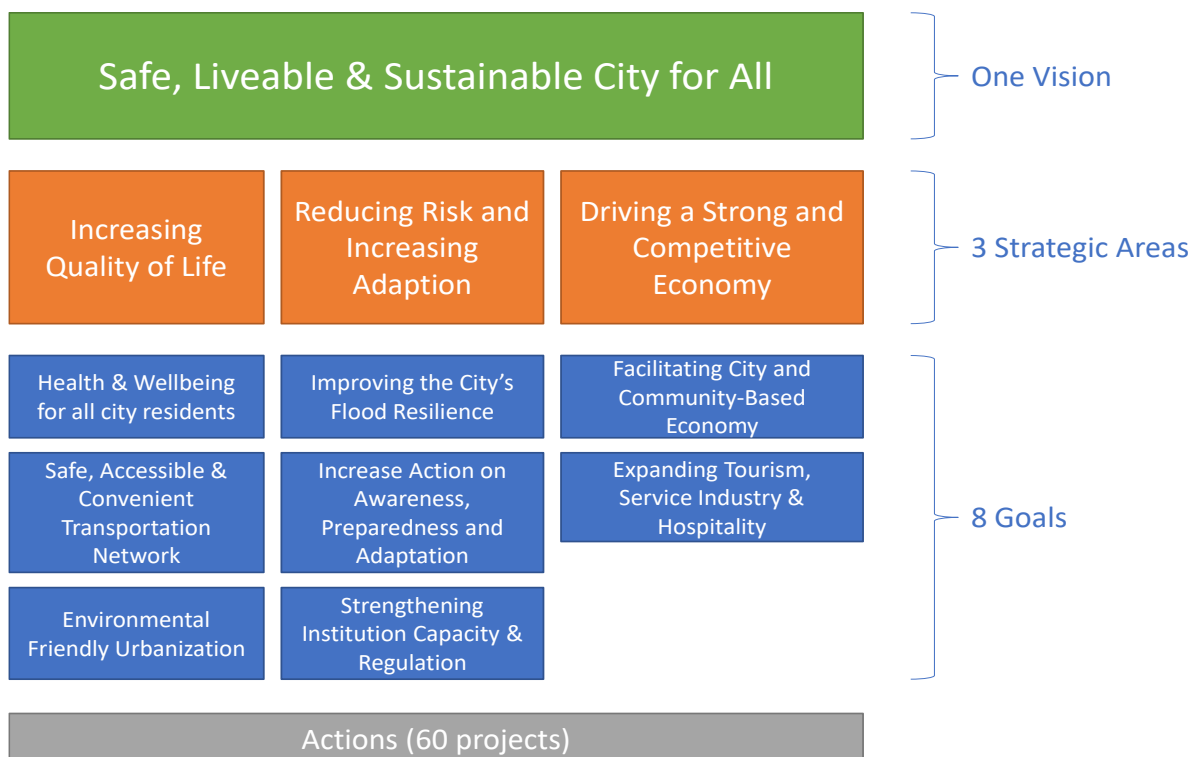


Fig. 10. Resilient Bangkok plan – Framework (by Author)

Initiatives for resilience

Energy

The Buildings of Department of Public Works (DPW) and the Department of Drainage and Sewerage (DDS) were upgraded as part of the Bangkok Masterplan on Climate Change strategy and budget allocated by the BMA. Lighting and air conditioning systems were replaced and post completion, the total energy consumption per year of both buildings dropped by approximately 57% compared to 2012 data (C40 Cities), cutting GHG emissions along with electrical costs. This is a positive example to show the commitment of the BMA to mitigate climate change.

Green Infrastructure

The Chulalongkorn University Centenary Park, inaugurated in October 2018, is the first public park and critical green infrastructure in the City of Bangkok in 30 years. The park uses design and engineering techniques to help manage runoff and flooding and was showcased for the ecological and social positive impacts of landscape architecture in dense urban areas.

A climate change adaptation case study, the park features rainwater reservoirs, constructed wetlands, retention pond, and detention lawns that can manage runoff and foster ecosystem services/biodiversity thriving by continuing green corridors from the surrounding campus to commercial area. Nature-based filtration techniques are used onsite for water treatment and there is water storage capacity during the wet season.

Urban planners, architects, designers have an important role to help the city become more resilient. To push not to rely on engineering-based solutions but rely on nature-based solutions instead to help with flood resilience, mitigate urban heat island effect and improve air quality and health and wellbeing.

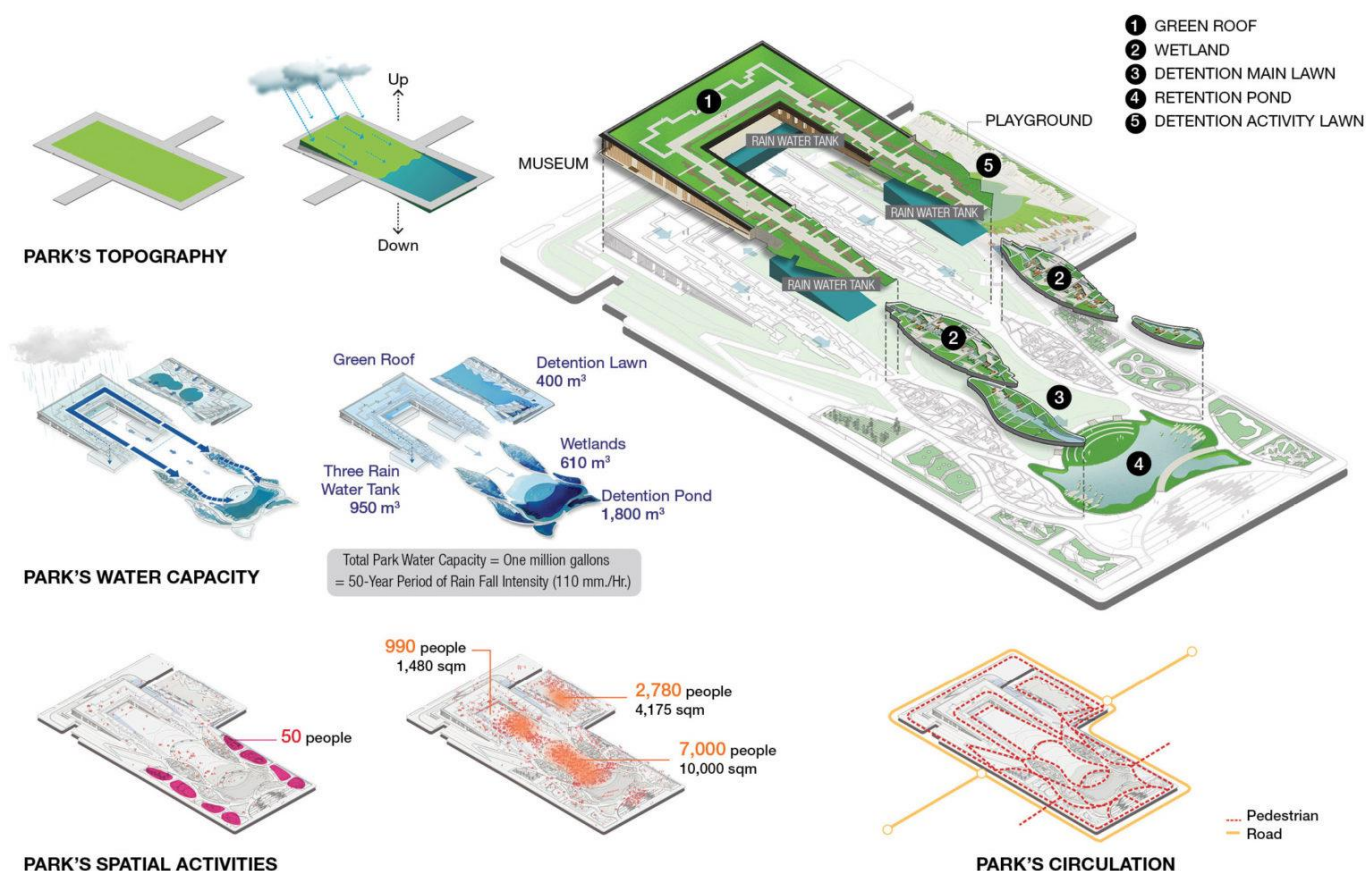


Fig. 11 Chulalongkorn University Centenary Park's strategies (Source: FuturArc, 2021).

Green Infrastructure/Agriculture - Hortillonnages

One pocket of green left in the City of Bangkok and vestige of the past is the peninsula **Bang Krachao**. Made of vegetable gardens in the form of *Hortillonnages* (man-made gardens in the middle of swamps), typical of a time prior to urbanization, these floating gardens have a productive agriculture system in place, as the canals around are used for irrigation during dry season. All species are edible on an “hortillon”. Wild patches of green mix with new residential developments.



Fig. 12 Bang Krachao “Hortillons” (Source: Green Pearls, Welcome to “Bangkok’s green lung”)

Social Housing

Through programs such as Baan Mankong (launched in 2003), the government have engaged members of the communities to come up with alternative housing solutions on existing site or at another location. The main objective is securing long term tenure. The government (and sometimes NGOs) then work with the local communities to come up with appropriate housing typology, as well and providing access to affordable finance.

A notable project is the redevelopment of squatter settlements along Khlong Lad Phrao canal in Jatujak district. Squatter settlements encroaching the canals have been removed to make ways for new flats and townhouses.



Fig. 13 Redevelopment of slums along Khlong Lad Phrao canal in Jatujak district (Source: CODI)

The largest slum in Bangkok is located at Khlong Teoi. As the containers port aims to be fully privatised, the slum is deemed to disappear. An urban development master plan was drafted, and following a devastating fire occurred last year, it was decided to destroy the Khlong Teoi slums in 2022.

The new development would include residential high rise and parks but raises the question of relocation for about 100,000 slums residents. Inhabitants desire to stay, as their families have lived here for generations, created a community and can live from tourism thank to the central location.

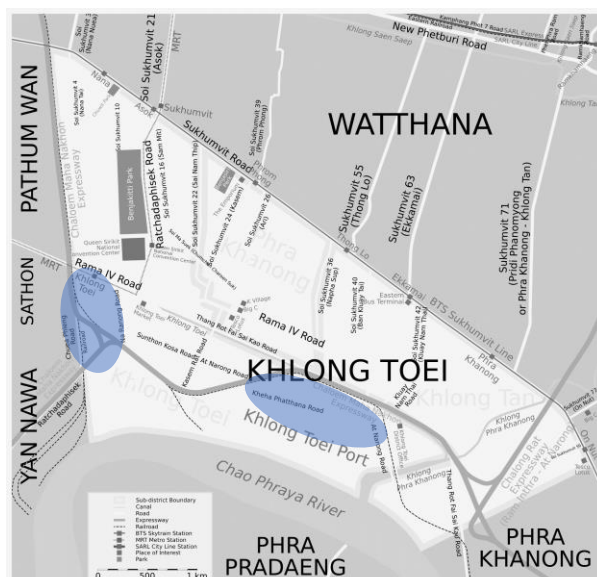


Fig. 14 Khlong Teoi approximate slum's location in blue. Aerial view of informal settlements. (Source: independent review of Bangkok slums by a resident, Pas Sean, Quora)

DISCUSSION AND CONCLUSION

From hard engineering approaches to environmental and people-focused ones?

The BMR approach to flood resilience comprises only engineering-based solutions such as new tunnels, waterways, sea walls, surge barriers, built with concrete that will not be enough to withstand flood extreme event. The alternative is to consider more “adaptive” infrastructure, and nature-based solutions approaches (e.g. mangrove restoration, wetlands), and people-focuses approaches to help design local plans and increase the community sense of responsibility.

To increase resilience to floods, and minimise social costs, it is also critical to prepare local communities and build a community response capacity, especially in vulnerable areas such as slums. The Bangkok Disaster Prevention and Mitigation plan (2010-2014) relies mostly on top-down actions but do not mention community participation, when direct involvement of communities before, during and post disaster has proved to be one of the most effective ways to enhance flood resilience. During the 2011 flood, help from the residents was extremely valuable to fire *fighters for carrying supplies and helping the most vulnerable*. (OECD, 2015). In other countries like the Netherlands, stakeholders including community representatives are engaged in the process of flood defence strategies to develop resilient solutions.

The Baan Mankong program started in 2003 was successful in that several projects were completed within the first two years. In the Charoenchai Nimitmai neighbourhood in Bangkok, a slum settlement next to railway tracks, the community formed a cooperative and used the Baan Mankong funding to purchase the land and rebuild the community. This shows how communities involvement and responsibility can be leveraged to reduce inequailities.

With projects of transforming slums to new upgraded developments, with the river sides being a prime location, there is a high risk that developers sell to a price slum dwellers could never afford. Plans to redevelop slums would therefore result into the displacement of about 100,000 people. Some programs offer public housing as detached houses for low income community, but far from the city centre. Relocating far from the centre is very difficult for people who lived all their lives in one place and to recreate a community environment. However positive change can be prompted by encouraging community initiatives and active participation at the new location.

Community initiatives

Many community initiatives have emerged in the City of Bangkok. One of them is “Precious Plastic Bangkok” for recycling, organising a plastic drop-off network to help clean up the city. Active slum dwellers run initiatives too, such as Cooking with Poo, Second Hand, or Helping Hands in the slum of Khlong Toei, to provide healthy meals and cheap clothes for the inhabitants, as well as work experience for young people, encouraging cooperation and community spirit.

The *Hortillonnage* gardens system in Bang Krachao explained in this report is also a good example of local initiative, that encourages a new way of living, slower and more in tune with nature and water.

How can Bangkok implement resilience actions?

Finance resilience

The BMA cannot generate the necessary revenue required to tackle the challenges presented in the previous sections. To upgrade the transport system/infrastructures and create new green areas, private investment and revenue from diversified sources would be needed.

Key performance indicators need to be adapted so that the BMA and the BMR methodologies align, and consistent data is produced to better monitor the progress and estimate the region's investment needs.

Besides, help from international development agencies and NGOs need to be considered for resilience projects. In the past decade, local and central governments have begun to support the shift towards resilience using the help of World Bank, USAID and other organisations. More projects need to come out of the ground at a faster pace to ensure the city is resilient by 2030.

Another key point is that around 80% of the land in the City of Bangkok is privately owned. This is an interesting fact to leverage and use opportunities to further involve property owners and developers in resilient actions.

Finally, creating a system shift towards a more resilient society would require significant amount of public investment across levels of government. Existing projects at the scale of the BMA could be expanded to the BMR scale. Public-private partnerships (PPPs) could be multiplied in several key strategic urban sectors such as transport, wastewater, flood protection. And municipal “green bonds” can be used to attract institutional investors. “The BMA does not at present issue municipal bonds but could easily do so with the support of the national government and/or international financial institutions, such as the World Bank Group, which has now issued close to USD 12 billion since its inception in 2008 and whose growth is accelerating rapidly” (OECD, 2015).

Coordination, cooperation

The OECD identified a lack of horizontal coordination between provinces, municipalities, local governments in the BMR.

To the extent feasible, all relevant stakeholders need to be involved in the development plan making of the city, for each area of opportunity to create new cohesive policies. The creation of the plan would include local communities, private sector, education, and networks of opinion makers (resilience champions) would promote urban resilience across all disciplines.

The CRO (Chief Resilience Officer) would need to have a key role across all different sectors and advise national and local governments. Have a role of coordinator between sectors and multi-disciplinary role, not restricted to the environmental department only.

In terms of flood resilience, the BMA has a solid flood control system, but due to the lack of coordination with other departments in the BMR, flood management is compromised. (Future Cities Programme).

Awareness

Raising public awareness among urban residents is a key social policy for enhancing community participation. Landowners and developers have a significant role to play in greening the city and promoting resilience. Awareness needs to be raised around climate change challenges and other sectors struggles at the government level too, to impact the policy makers.

Covid-19 and future challenges

The pandemic has aggravated the inequalities in the city. Bangkok slum residents were forced to live in very poor conditions during the Covid-19 outbreaks, isolated from the rest of the population. A holistic approach needs to be implemented, and key challenges exposed in this report to be addressed. A balance needs to be found between health, economic growth, and environmental stresses.

There are still many areas of Bangkok without access to public transport which isolate communities. Improvements are needed to the transport system through integration of transport modes, public transport-oriented development. The city is still at high risk of flooding; more green space needs to be implemented. Better horizontal coordination needs to happen between local municipalities and departments, along with efficient data sharing to better determine the key issues to focus on for integrated planning. Finally, community-based development projects should be prioritized and educational programmes about the challenges conducted.

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