Redefining Bangkok’s Inclusive Water-Based Society
Flood Resilience Planning of Adaptive and Performative Hybrid Infrastructure Network
The Chao Phraya River Basin & Tributaries

Bhumipol Dam

Bangkok

Ping, Wang, Yom and Nan rivers merging to form the Chao Phraya

Nakhon Sawan

Chao Phraya

Sirikit Dam

Ayutthaya (Former capital of Thailand)

Bangkok (Current capital of Thailand)

Delta city near the mouth of the sea

Gulf of Thailand

The choke point of the rivers' confluence from branches, loops and canals of a braided distributary network
Vegetation (1974)

Agricultural Area (mainly rice)
Tropical Evergreen Forest
Teak Forest
Broadleaf Deciduous Forest
Mangrove

Geomorphological

Fan-Terrace Complex Area
Floodplain
Old Delta
Young Delta
Intermountain Basin

Bangkok


Thailand water cities with different geomorphological characteristics (source: Bangkok’s Distributary Waterscape Urbanism, Danai Thaitakoo, Brian McGrath, Suebsiri Srithanyarat, 2015)
Modified conceptual section of indigenous peri-urban settlement with water management
Living with Water

Orchards

Water Management

Rice Field

Flood Resilience

Agriculture

Canal House

Water Market

Society

International Trading Port

Historical settlement of palaces and temples on river levee

Cultural and festive activities by the river and canals

Natural Resource Recreation
Rapid increase of land-based built-up area at the expense of cultivated land and the hydrological matrix
(source: Bangkok: The Ecology and Design, Danai Thaitakoo, Brian McGrath, Suebsiri Sritanyarat, 2013)
Water as a way of living

as a threat of life
Bhumipol Dam on Ping River (1964)

Sirikit Dam on Nan River (1977)

2011 Flood Area (10 years-flood)

Gulf of Thailand

Bangkok

MaeKlong River

Tachin River

Chao Phraya River

Centralized water management system to extend agricultural production throughout the year

Pasak River

King’s Dike (after 1983 flood)

River Dike (after 1995 flood)
Living against Water

- Abandoned agricultural area
- Mixed Water
- Drainage Canal
- River Dike +3.00 M.MSL
- River Dike +3.00 M.MSL
- River Dike +3.00 M.MSL
- Detached relation with water
- Canal as back of the community
- King's Dike +3.00 M.MSL
- Industrial site on floodplain

1983 +2.13 M.MSL
1995 +2.27 M.MSL
2011 +2.03 M.MSL

77 km. dike along both sides of canal & river
River mainly as bypass drainage to the sea
Water as threat and obstruction for daily system

77 km. dike along both sides of canal & river
River mainly as bypass drainage to the sea
Water as threat and obstruction for daily system
**Flash Flood**
May - Oct (Seasonal)
Urban Capacity:
60 mm / hr

**River Flood**
Approx. 10 years
River Capacity:
3000 cm³/sec (max)
Flash Flood
Urban Drainage Network

Rainfall (Precipitation) → Rooftop Runoff → Road (Surface Runoff) → Urban Settlement (Run off/Waste)

Rooftop Runoff → Sewage On-site treatment → Mega Drainage Tunnel (Mixed Water)

Culvert (Mixed Water) → Canal (Drain Out) → Water Treatment Station

River Flood
Dike Protection & Management

Contaminated water → Flood → King's Dike (Protect the City) → Floodplain (Agriculture Area) → Nearest River (Drain Out)

River (From Upper Region) → Flood → Chao Phraya River (Drain Out) → Gulf of Thailand (Tidal Influence)

Pumping Station & Sludge (Control) → Water Treatment Station
Engineering Water Management - Separation of Water from Daily System

Flood Dike
Along River & Canal
- 77 km.
- + Highten up the dike to 2.80-3.50 m. from sea level

Flood Gate
& Pumping Station
- 227 Units
- 174 Units

Mega Drainage Tunnel
- 1682 Units
- Construction of extra tunnels cost 22,975.865 million baht

Culvert
- 6400 km.
- Water management rely mainly on network of underground drainage system

Water management rely mainly on network of underground drainage system
- 6400 km.
- + Construction of extra tunnels cost 22,975.865 million baht
2037 Urban Expansion
Commercial & CBD Hub with Transportation Infrastructure

Future Urban Expansion of Flood Vulnerable Districts

Emerging Commercial & Transportation Hub
Sub-Urban Development
Main Road Network
Existing Railed Public Transportation Network
Extended Railed Public Transportation Network
Sub-urban / Agricultural Area
Urban Development Area
Economy driven transportation lead to one side promotion of infrastructure for vehicles, extending built-up areas along the road lines, while ignoring pedestrian living qualities of social and ecology systems on ground level.
Preserved Floodplain
Coastal Floodplain
Public Park
Government Sector
Private Sector
Green & Blue Infrastructure
Retention Pond
Inner Urban Area
Historic Cultural District
Downtown CBD
Agricultural Area
Green Connector
Existing Green Road & Canal

G&B Infrastructures for water management purpose
- Preserved Floodplain
- Coastal Floodplain
- Agricultural Area
- Retention Pond

G&B Infrastructures for recreational purpose
- Public Park
- Government Sector
- Private Sector
- Urban Settlements
- Green Connector
- Existing Green Road & Canal

WHO Standard
BANGKOK
Green Space
Accessible Green Space

9.00
6.06
3.30
SQ.M./PEOPLE
SQ.M./PEOPLE
SQ.M./PEOPLE

Bangkok Green Space
WHO Standard
9.00
6.06
3.30
SQ.M./PEOPLE

SQ.M./PEOPLE
SQ.M./PEOPLE
SQ.M./PEOPLE
G&B infrastructure in metropolitan area are separated in fragments by built-up areas and grey infrastructure. Social and ecological systems are limited in certain areas apart from surrounding urban systems, unlike socio-ecological network of the water infrastructures and agricultural farmland in the past.
Grey Infrastructure

Vehicle-based Transportation Development
Expansion of Flood Vulnerable District

Engineering Water Management
Separation of Water from Daily Life

Fragmented Green & Blue Infrastructure
Limitation of Social and Ecology Systems
Flood Risk

- Flood Management + Economic (Regional)
- Vehicle-based Transportation Development (Expansion of Flood Vulnerable District)
- Engineering Water Management (Separation of water from daily life)
- Decline of Floodplain due to Urban Expansion
- Grey Infrastructure (Urban)
- Fragmented Green & Blue Infrastructure (Limitation of social & ecology system)
- Behavior + Daily System (Local)
- Dry Living Condition against Flood
- Lack of Adaptation to Environmental Changes
- Negative Perception towards Flood / Water

Vulnerability
The maps display a projection of total accumulated rain over one year of Thailand compared to the 1980’s rainfall rate. The annual precipitation was about 1000-1200 mm. in 1980 and rise to 1500 mm. in 2019. The precipitation rate keeps rising each year as the projection indicates the increase over 25-50% in various areas by 2090.
From adaptive water-based society to water defensive car-based megapolis
Evolutionary Resilience

"Adapt and Evolve With Flood"

Engineering Resilience

"Protect From Flood"
Four-dimensional framework for resilience building
(source: Evolutionary Resilience and Strategies for Climate Adaptation, Davoudi, S., Brooks, E. & Mehmood, A.)

“Living with Water”
“To transform existing grey infrastructures into hybrid flood adaptive and performative resilience system of Bangkok, reducing flood risks, and provoking socio-ecological transformation with water-based identity.”
• How flood management could be integrated as part of daily system to stimulate social process of living with environmental changes towards adaptive and performative landscape?

• How green and blue infrastructures could be integrated with the existing grey infrastructures to perform as new hybrid resilience network reducing flood risk?

• How could the new flood management model influence the change of perception towards water, inducing adaptation efforts and coping with flood impacts in different scales?
Grey Infrastructure + G & B Infrastructure = Hybrid Infrastructure Network
Adaptive Programs
Living with Environmental Changes

Wet (Flood)

Dry (Regular)

Integrated Infrastructure Network
Transportation + Water Management + Green & Blue Network

Flood Management Strategies
Reducing Flood Risks

Tolerance

Harvest

Store

Infiltrate

Convey

Wet (Flood)

Adaptive Programs
Living with Environmental Changes
SITE SELECTION
Pathum Wan Downtown - Commercial & Transportation Hub Model
1. Key Model of future urban expansion (Downtown Commercial District)

2. High potential development area of government and crown property with public landuses

- Crown Property
- Government Property

Landuse:
- High Rise Commercial & Office Building
- Low Rise Commercial (Mixed Use)
- Educational Institution
- Recreation & Green Space
- Institution
- High Density Residential
Water Management Infrastructure

Urban drainage by underground pipe & tunnel system to San Saeb canal and Chao Phraya river

Levels
- +0.00 - 0.50 m.
- +0.50 - 1.00 m.
- +1.00 - 1.50 m.

Water Management
- Underground Drainage Pipe (Main Road)
- Underground Drainage Tunnel
- Main Drainage Flow
- Run-off Catchment Area (Low Area)
- Main Pumping Station
Green & Blue Infrastructure

- Public Park
- Future Development Public Park
- Potential Green Space of Government Sector
- Potential Green Space of Private Sector
- Green & Blue Connector Route
- Potential Connector (Avenue)

Existing Green Connector: Boulevard
Existing Blue Connector: Canal
Potential G&B Connector: Avenue
DESIGN IMPLEMENTATION
1. Commercial Artery
   (Harvest + Infiltrate)
   Mass Transit Route

2. Life Corridor
   (Convey + Tolerate)
   Green & Blue Connector Route

3. Underline Park
   (Store + Tolerate)
   High Speed Traffic Route

4. Soaked Community
   (Store + Infiltrate)
   Slow Traffic Route
1

Commercial Artery
( Harvest + Infiltrate )
Mass Transit Route
Disconnection of public sidewalk and set-back plaza

Air and noise pollution from traffic congestion

Traffic congestion of unorganised public transportation transit

Isolated & unutilized green space of traffic island

Underground drainage of mixed sewage and run-off

Limitation of urban ecology by public utility systems
Filtered water from buildings

Separation of run-off and sewage system

Visible surface drain

Store & reuse for maintenance

Vertical Garden

Scent

Pollution Filtration

Bio-Swale - Infiltration

Shorea roxburghii
Lagerstroemia loudonii
Shorea roxburghii

Crinum asiaticum
Gardenia jasminoides
Schefflera actinophylla

Dolichandra unguis-cati
Ruellia tuberosa
Polianthes tuberosa

Shorea roxburghii
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Gardenia jasminoides

Crinum asiaticum

Dolichandra unguis-cati

Ruellia tuberosa

Polianthes tuberosa
Informal street economy on sidewalks around commercial nodes

Alternative Pedestrian Connection (Skywalk)

Engineering solution
Underground drainage of mixed sewage and run-off

Lack of ecology system with unfriendly environment of sky-train structure

Air and noise pollution from traffic congestion
Traffic congestion of unorganised public transportation transit
Connection between commercial area with pedestrian sidewalk

Informal street economy on sidewalks around commercial nodes

Air and noise pollution from traffic congestion

Traffic congestion of unorganised public transportation transit

Underground drainage of mixed sewage and run-off
Additional Underground Pedestrian Connection
Traffic Lane
Traffic Lane
Metro Station
Metro Station
Enlarged Traffic Island
Bus Transit & Bio-swale
Bio-swale
Permeable
Bike lane
Integrated Sidewalk & Set-back Plaza
Integrated Sidewalk & Set-back Plaza
Commercial Artery: Metro (Harvest + Infiltrate)
Life Corridor

(Convey + Tolerate)

Green & Blue Connector Route
Disconnection of social & ecology system by wide traffic lanes

Limited period parking space (Flexible street uses)

Underground drainage of mixed sewage and run-off

Isolated & unutilized green space of traffic island

Limitation of urban ecology by public utility systems

Public Park  Sidewalk  Traffic Lane  Traffic Island  Traffic Lane  Sidewalk  Set-back Plaza
Extended Linear Park Connector (Vegetative Ditch)

Set-back Plaza

Sidewalk Bio-swale

Adaptive Street (Vehicle & Pedestrian)

Recreation and gathering destination

Urban ecology restoration

Extended urban sanctuary

Room for water in urban area

Natural border (park polder system)

Organize street vendor system

Public Park

Adaptive street uses (vehicle & pedestrian)

Recreation and gathering destination

Urban ecology restoration

Extended urban sanctuary

Room for water in urban area

Underground utility system

Life Corridor: Boulevard (Convey + Tolerate)

Room for water in urban area

Sidewalk Bio-swale

Pedestrian Street (Event)

Sidewalk Bio-swale

Set-back Plaza

Life Corridor: Boulevard (Convey + Tolerate)
<table>
<thead>
<tr>
<th>Shaded tree</th>
<th>Deciduous</th>
<th>Scent</th>
<th>Attractive to Wildlife</th>
<th>Natural Filtration by Vegetative Stripe (Flood Tolerance)</th>
<th>Soil Protection</th>
<th>Groundcover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Samanea saman (Jacc.)</td>
<td>Cassia fistula L.</td>
<td>Shorea roxburghii G.Don</td>
<td>Flacourtia rukam</td>
<td>Achyranthes aspera L.</td>
<td>Melinis repens</td>
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- Visible surface drain
- Store and manage by park system
- Separation of run-off and sewage system
- Convey to nearest G&B system
- Filtered water from buildings
- Emergency urban flood storage
- Deciduous
- Scent
- Attractive to Wildlife
- Natural filtration by vegetative stripe (flood tolerance)
- Soil Protection
- Groundcover
Extended use of sidewalk space for informal street economy

Limitation of urban ecology by public utility systems

Underground drainage of mixed sewage and run-off

Sidewalk  Traffic Lane  Sidewalk
Life Corridor: Boulevard
(Convey + Tolerate)
Blue Connector Route: Drainage Canal (City Moat)

- Lost of water-related traditional uses (Transportation and Water Market)
- Difficulty of accessibility wide traffic lane (car-based)
- Disconnection with water (social & ecology system)

Limited period parking space (Flexible street uses)

3 - 4 m. depth

Sidewalk  Traffic Lane  Sidewalk  City Moat  Sidewalk  Traffic Lane  Sidewalk
Phadung Krung Kasem Canal

Urban ecology restoration

Recreation and gathering destination

Accessible to water

Water-related programs

Extended Riparian zone

Organize street vendor system

Underground utility system

Life Corridor: Ecological Canal (Convey + Tolerate)
Canalside - Flood Tolerance + Shaded Tree

Tamarindus indica
Ficus religiosa
Salix babylonica
Elaeocarpus hygrophilus Kurz

Water Filtration Edge

Lepironia articulata
Cyperus papyrus
Typha angustifolia L.

Aquatic Plant - Floating

Eichhornia crassipes
Pistia

Separation of run-off and sewage system

Visible surface drain

Natural filtration by vegetative stripe (flood tolerance)

Flood Tolerance with water level changes

Visible surface drain

Convey to nearest G&B system

store and manage by canal system

Filtered water from buildings
Blue Connector Route: Drainage Canal (Ferry Route)

Disconnection of pathway and green space related to surrounding landuse

Narrow typical pathway connector between station

4 - 6 m. depth

Varies 16 - 30 m.

Pathway
Transportation Canal
Pathway

San Saeb Canal
San Saeb Canal

Transportation canal

Pathway

Varies 16 - 30 m.

Life Corridor : Ecological Canal
(Convey + Tolerate)

Extended Ecological Edges
(Potential Public Areas)
Underline Park
(Store + Tolerate)
High Speed Traffic Route
High Speed Traffic Route

- Low Rise Commercial (Mixed Use)
- Institution (temple)

Typical Elevated Highway (with space underneath)

On-ground Toll Road (disconnect from surrounding)

Local Mixed-use Shophouse
Seperation from surrounding communities

High Speed Traffic Route: Highway 1: 150

Parking Space / Local Street Food Vendor

Main Traffic Lane

Sidewalk

Underground drainage of mixed sewage and run-off

Unutilized area and misused activities by locals underneath highway structure

Lack of ecology system with unfriendly environment of highway structure

20 - 40 m. (varies to highway structure)

Seperation from surrounding communities
Bio-retention /Detention
Main Traffic Lane
Sidewalk
Multi-purpose Courtyard
(Water Square)
Promote local uses from surrounding communities
Reutilize existing abandoned area and infrastructure
Room for water in urban area
Urban ecology restoration underneath structure
Recreation / gathering area of local communities
High Speed Traffic Route: Underline Park (Store + Tolerate)
Jogging Track
Main Traffic Lane
Sidewalk
To nearest urban drainage system

Natural filtration by native plants

Store & reuse after filtration

Support surrounding run-off

Separation of run-off and sewage system

Harvest run-off from highway
Soaked Community
( Store + Infiltrate )
Slow Traffic Route
Suan Luang Square (Pedestrian friendly planning)

Siam Square (Car-based planning)

Chulalongkorn University

Sam Yan (Individual mixed-use shophouse)

Educational Institution
Low Rise Commercial (Mixed Use)
Crown Property of Chulalongkorn

Institution: Chulalongkorn Green University
Low-rise Commercial: Siam Square Complex
Pedestrian friendly pathway network

Connection with green & blue infrastructure service for both social and ecological systems

Urban Green Spaces
Plaza and Green Spaces inside the Project
Project Boundary
Entrance Gate
Parking Building

Slow Traffic Route : Institution
1 : 150

Front Plaza  Sidewalk  Bike Lane  Slow Traffic Lane  Bike Lane  Sidewalk  Green Spaces & Activity Courts
Sidewalk Safety Zone
Front Plaza
Canal - Street
Natural Border Polder System
Green Spaces & Activity Courts

Soaked Community: Institution (Store + Infiltrate)

Filtered water from buildings
Store and manage as water supply
To nearest urban drainage system
Infiltration grounds

Commercial Artery (Public Transportation Route)
Life Corridor (G&B Connector Route)
Canal - Street Network
Extended Network
Slow Traffic Route: Low-rise Commercial

- Siam Square
- Sam Yan
- Suan Luang

- Local mixed-use Shophouse
- Underground drainage of mixed sewage and run-off

- Low-rise commercial project with car-based planning
- Underground drainage of mixed sewage and run-off

- Low-rise commercial project with pedestrian friendly planning
- Mix of on-ground green solution with existing engineer solution
Soaked Community: Low-rise Commercial (Store + Infiltrate)
CONCLUSION
Integrated Hybrid Infrastructure Network
Functioned as Interrelated Performative Flood Management

Co-benefit of Social and Ecology Services through Public Space Development

Water-based Identity / Part of Living Condition
Induce Adaptation of Perception and Lifestyle
Downtown Network
Collaboration of Urban & Sub-urban Management

Collaboration with Flood Dike + Floodplain Management

Collaboration of Delta City Network

Influencing Other Flood Resilience Living Models of Different Regions

Collaboration with Regional Centralized Management