

Regional
Learning Note

#4

Enhancing Urban Resilience through Connected Urban Green Spaces for Urban Flood Risk Reduction:

A Pilot Initiative in Khon Kaen City



Urban-Act
Integrated Urban Climate Action
for Low-Carbon & Resilient Cities





Enhancing Urban Resilience through Connected Urban Green Spaces for Urban Flood Risk Reduction:

A Pilot Initiative in Khon Kaen City

**© 2026 United Cities and Local
Governments Asia-Pacific (UCLG ASPAC)**

All rights reserved.

No part of this publication may be reproduced, stored, or transmitted in any form or by any means without prior written permission from the publisher.

The Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety (BMUKN) and implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, in partnership with UNESCAP, IREUS Stuttgart University, and TU Dortmund University.

The views expressed in this publication do not necessarily reflect those of the funding partners, participating institutions, or affiliated organisations. The designations and presentation of material do not imply any opinion concerning the legal status of any country, territory, city, or area, or the delimitation of its frontiers or boundaries.

Citation:

UCLG ASPAC. (2026). *ASPAC Learning Note #4: Enhancing Urban Resilience through Connected Urban Green Spaces for Urban Flood Risk Reduction: A Pilot Initiative in Khon Kaen City*. Jakarta: UCLG ASPAC.

Coordination

United Cities and Local Governments Asia-Pacific (UCLG ASPAC)
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP)
Khon Kaen Municipality, Thailand
Participating cities and institutions from China, Indonesia, Lao PDR, Malaysia, and Thailand

Editors and published by:

United Cities and Local Governments Asia-Pacific
Jakarta, Indonesia

✉ secretariat@uclg-aspac.org  www.uclg-aspac.org

Contributors

Agung Zulhatta,
Research and Learning Officer,
UCLG ASPAC

Cemara Dinda,
Knowledge Management Communication
Officer – UCLG ASPAC

Chutima Jongpakdee
Senior Advisor, GIZ Thailand

Executive Editors

Dr Bernadia Irawati Tjandradewi,
Secretary General, UCLG ASPAC

M. Helmi Abidin,
Regional Project Manager – Urban-Act
Project, UCLG ASPAC

FOREWORD



Khon Kaen, like many rapidly growing cities, is increasingly experiencing the impacts of climate change and urbanisation. Heavy rainfall, urban flooding, the loss and fragmentation of green areas, and increasing pressure on urban infrastructure require us to rethink how we plan and manage our city. Addressing these challenges requires more than conventional infrastructure solutions. We need integrated approaches that work with nature and connect urban development with climate resilience.

The City Pairing Workshop provided an important opportunity

for Khon Kaen Municipality to learn from and exchange experiences with partner cities and organisations. Through discussions, field visits, technical sessions, and practical exchanges, we explored how connected urban green spaces and nature-based solutions (NbS) can contribute to flood risk reduction while providing wider benefits for our communities, including improved environmental quality, public spaces, biodiversity, and quality of life.

The proposed pilot initiative demonstrates the importance of moving from individual green spaces towards a connected urban green space network. By linking parks, waterways, drainage corridors, wetlands, public spaces, and other green and blue assets, we can strengthen the city's capacity to absorb and manage stormwater while creating more attractive and liveable neighbourhoods. This approach

also encourages us to look beyond administrative boundaries and consider the urban landscape as an interconnected system.

Importantly, the learning from this initiative is not only about physical interventions. It also highlights the importance of multi-level governance, community participation, partnerships, knowledge exchange, and long-term planning and financing. Building urban resilience requires collaboration among local governments, national agencies, communities, academia, the private sector, and development partners. The experience of Khon Kaen demonstrates that city-to-city learning can help local governments identify practical solutions and adapt them to their own local contexts.

On behalf of Khon Kaen Municipality, I would like to express my sincere appreciation to UCLG ASPAC and GIZ Thailand, under the Urban-Act Project, for their continued partnership and support. I also extend my gratitude to all participating cities, experts, institutions, and stakeholders

who contributed their knowledge, experiences, and ideas during the City Pairing Workshop.

We hope that this learning note will serve not only as a record of the pilot initiative, but also as a practical reference for further action. Khon Kaen Municipality is committed to continuing this journey towards a more climate-resilient city and to strengthening collaboration with other cities in Thailand and across the Asia-Pacific region.

Together, through connected urban green spaces, nature-based solutions, innovation, and strong partnerships, we can reduce urban flood risks and create a greener, healthier, and more resilient Khon Kaen for present and future generations.

“Nature is not separate from our city—it is part of our infrastructure, our resilience, and our future.”

Ms. Nutchareewan Dondeeloet,
Deputy Mayor of Khon Kaen Municipality

TABLE OF CONTENTS

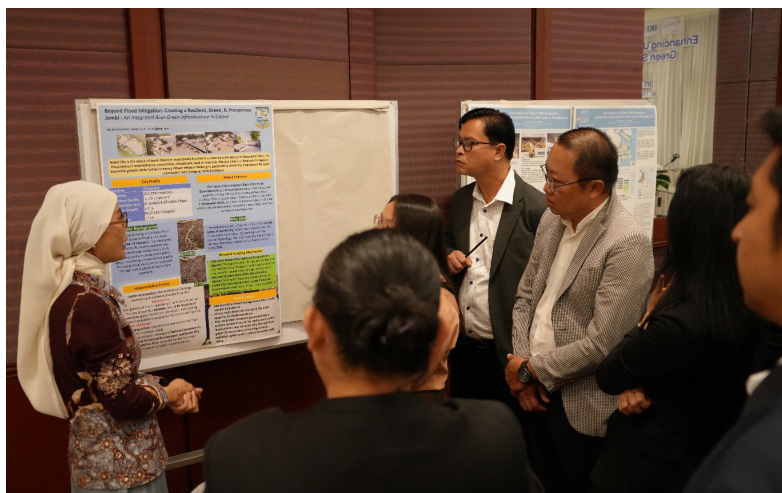
01 FOREWORD	iii	02 TABLE OF CONTENTS	v
.....			
03 INTRODUCTION	01	04 BACKGROUND	04
.....			
05 FIELD-BASED LEARNING	08	06 CASE STUDY	12
Khon Kaen, Thailand	12	Banda Aceh, Indonesia	32
Shanghai, China	17	Vientiane, Lao PDR	37
Klang, Malaysia	22	Luang Prabang, Lao PDR	42
Penang, Malaysia	27	Hat Yai, Thailand	47
.....			
06 KEY LESSONS	53	07 THE WAY AHEAD	57

INTRODUCTION



Cities across Asia and the Pacific are increasingly facing urban flooding, heat stress, water pollution, and declining environmental quality. These risks are intensified by rapid urbanisation, the expansion of impermeable surfaces, the loss of wetlands and open spaces, and more frequent short-duration rainfall events. In many cities, flood risk is no longer only a drainage problem. It is also a planning, land-use, ecological, and governance challenge.

Connected blue-green infrastructure offers a practical pathway for strengthening urban flood resilience. Wetlands, lakes, rivers, canals, parks, green corridors, retention ponds, bioswales, rain gardens, permeable surfaces, and tree-lined streets can function as part of the city's climate infrastructure. When planned as a connected system, these assets can store, slow, filter, absorb, and safely release stormwater while also supporting biodiversity, urban



cooling, public health, recreation, and community wellbeing.

In this Learning Note, connected blue-green infrastructure refers to the integration of natural, semi-natural, and engineered systems into urban planning and water management. It means treating green spaces and water bodies not as leftover land or beautification elements, but as functional infrastructure that supports flood-risk reduction, climate adaptation, environmental protection, and liveable urban development.

Recognising these challenges, the Urban-Act Peer-to-Peer Learning and Knowledge Exchange on Enhancing Urban Resilience through Connected Urban Green Spaces for Urban Flood Risk Reduction was convened in Khon Kaen, Thailand, from 9 to 12 July 2026. The exchange brought together representatives of cities and local governments, institutions, experts, and practitioners and examine how Nature-based Solutions (NbS), blue-green infrastructure such as sponge city planning, retention ponds and integrated

urban planning such as wetland management, climate-responsive public spaces, to sustainable financing, and city-to-city cooperation can strengthen resilience to flooding and other climate risks

A key feature of the exchange was its practical learning approach. Through city presentations, poster discussions, site visits, expert

reflections, thematic working groups, and recommendation sessions, participating cities examined not only what solutions had been implemented, but also how they were planned and financed, governed, maintained, what challenges were encountered and how relevant elements could be adapted to Khon Kaen's local conditions.

BACKGROUND



Credit: Khon Kaen Municipality

Urban Flood Risk and Connected Blue-Green Infrastructure in Asia-Pacific Cities

Urbanisation is transforming cities across Asia and the Pacific. As urban areas expand, natural landscapes are increasingly converted into roads, buildings, housing estates, commercial areas, and other hard surfaces. This transformation reduces the ability of land to absorb rainfall and increases the speed and volume of stormwater runoff. At the same

time, many cities are experiencing heavier and more concentrated rainfall events, placing greater pressure on drainage systems, canals, rivers, and flood-control infrastructure.

While large metropolitan areas often dominate discussions on climate risk, many intermediary and regional cities are facing similar pressures with more limited fiscal, technical, and institutional capacity. These cities frequently still retain important

ecological assets, including wetlands, lakes, rivers, canals, agricultural land, parks, and vacant open spaces. If protected and connected early, these assets can support flood regulation and long-term urban resilience. If neglected, they may be converted or degraded, making future flood mitigation more costly and difficult.

Urban flooding therefore cannot be understood only as a technical drainage problem. It is also the result of how cities plan land, regulate development, protect ecosystems, manage water, and coordinate across institutions. When wetlands, lakes, rivers, retention areas, and green spaces are disconnected from spatial planning and infrastructure investment, cities lose natural systems that once helped slow, store, and filter water. Flood risk then becomes a cumulative product of environmental degradation, fragmented urban management, and infrastructure systems that were not designed for changing rainfall and land-use conditions.

Environmental and Urban Resilience Implications

The loss of permeable surfaces and ecological assets has direct implications for urban resilience. Built surfaces such as asphalt and concrete absorb heat and intensify urban heat conditions. Reduced vegetation limits the cooling function of urban ecosystems, while degraded waterways and insufficient stormwater management can increase water pollution, sedimentation, and public health risks. Flooding also affects mobility, livelihoods, public services, schools, health facilities, and local economies. In dense urban areas, even short periods of inundation can disrupt daily life and create long-term pressure on municipal budgets.

Governance, Financing, and Policy Context

Implementation, however, depends on governance as much as design. Cities need clear institutional responsibilities, cross-departmental coordination, reliable data, hydrological analysis,

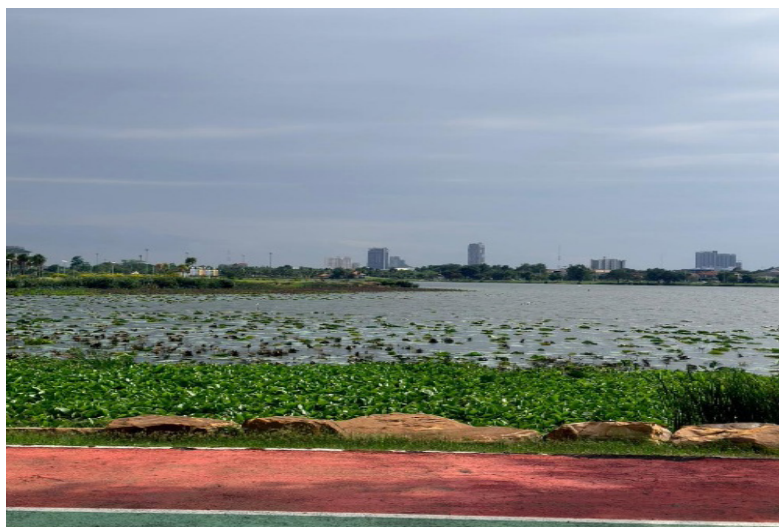
land-use control, community engagement, and long-term maintenance arrangements. Without these enabling conditions, nature-based solutions risk remaining small pilots or isolated public-space improvements. Financing is also central. Many blue-green infrastructure projects produce multiple benefits, including avoided flood damage, improved water quality, urban cooling, biodiversity conservation, recreation, tourism, and local economic activity. These benefits are often not fully captured in conventional infrastructure budgeting.

Project preparation is therefore important. Cities need to translate broad resilience ambitions into technically sound and investment-ready proposals. This includes identifying priority sites, analysing flood and rainfall data, assessing land ownership and social impacts, estimating construction and maintenance costs, and demonstrating the wider economic and environmental value of proposed interventions. It also requires realistic phasing.

Small-scale pilots can help test design approaches, build public support, and generate evidence before cities move toward larger connected systems.

Connected blue-green infrastructure also aligns with wider international policy frameworks. The 2030 Agenda for Sustainable Development calls for inclusive, safe, resilient, and sustainable cities. The Paris Agreement reinforces the importance of local climate adaptation and mitigation. The Sendai Framework highlights disaster risk reduction and resilience, while the New Urban Agenda promotes integrated urban planning, environmental protection, and sustainable urban development. These frameworks provide local governments with a policy basis for linking flood-risk reduction with climate action, biodiversity protection, public health, and sustainable infrastructure investment.

For Asia-Pacific cities, the key challenge is to move from fragmented responses towards



connected systems. This requires cities to recognise ecological assets as infrastructure, integrate blue-green networks into spatial and investment planning, strengthen community participation, and prepare projects with sufficient technical,

economic, and institutional evidence. The future of urban flood resilience will depend not only on larger drains or stronger embankments, but on how cities plan, govern, finance, and connect water, land, nature, and people.

FIELD BASED LEARNING



Connected Wetlands and Urban Water Management

📍 Khon Kaen Municipality, Thailand

The field-based learning in Khon Kaen enabled participants to examine how Khon Kaen's existing urban green spaces, including its wetlands, canals, lakes, drainage infrastructure and waste management facilities can be understood as part of one connected flood-resilience system. Rather than observing individual sites as separate

public spaces or water bodies, participants were invited to examine how these assets could work together to store, slow, regulate, and release stormwater during heavy rainfall events. The sites also illustrated the Thai *Kaem Ling*, or “monkey-cheek,” principle, through which lakes and wetlands temporarily receive excess water during periods of



intense rainfall, and gradually releases it once downstream capacity becomes available.

The visit began with discussions on Khon Kaen's integrated water-management approach, which links stormwater management, flood mitigation, wastewater infrastructure, and the use of existing urban wetlands. This helped participants understand that urban flood resilience depends not only on new infrastructure, but also on how cities operate and connect the assets they already have. Parks, ponds, canals, weirs, pumps, and treatment facilities can become more effective when

planned as interdependent parts of a wider blue-green infrastructure network.

City Gate Park offered an example of how existing public space can be reimagined as multifunctional climate infrastructure. In addition to serving as recreational areas, suitable parts of the park could be designed to absorb, slow or temporarily retain stormwater. For participating cities, the site demonstrated that sponge-city principles do not always need to begin with large-scale projects. Smaller and visible interventions in public spaces can help test concepts, build public understanding,



and prepare the ground for wider systems of connected wetlands and green corridors.

Buong Thung Sang Pond and Public Park illustrated the role of wetlands as downstream flood buffers. Under normal conditions, water can continue through adjoining canals, but during high water levels, excess flow can enter the wetland and be stored temporarily. The discussion highlighted

how natural wetlands can be managed and protected; and where technically appropriate, restored or improved to strengthen water-storage capacity while maintaining their ecological functions. Issues such as sedimentation, water quality, habitat protection, encroachment, and wetland vegetation were central to understanding the long-term management needs of such systems.

Bueng Kaen Nakhon Public Park showed how an inner-city lake can function as a balancing pond connected to the urban drainage network. The lake has approximately five million cubic metres of total capacity, including around three million cubic metres of active flood storage. During heavy rainfall, excess water can flow from connected canals into the lake for temporary storage.



Once rainfall decreases and canal levels fall, the water can gradually return to the drainage system, reducing pressure on downstream infrastructure. The site also highlighted the importance of water-quality monitoring, particularly after the first major rainfall following a dry period, when pollutants and organic matter may be flushed into the lake.

Across the sites, the main lesson was that urban flood-risk reduction requires cities to move beyond isolated drainage solutions. Khon Kaen's experience shows the value of treating water bodies, wetlands, canals, and public spaces as a connected urban system. This approach can strengthen flood resilience while supporting biodiversity, public recreation, urban cooling, water-quality management, and long-term climate adaptation.



■ CASE STUDY

Connecting wetlands, parks, and water systems for urban flood resilience

📍 Khon Kaen, Thailand

Khon Kaen Municipality's experience shows how existing urban wetlands, lakes, parks, canals, and drainage systems can be reimagined as a connected blue-green infrastructure network. Located in northeastern Thailand, the municipality covers approximately 46 square kilometres, while the

wider water catchment affecting the city extends beyond its administrative boundary. Water flows from the western side of the city towards the east, meaning that flood management depends not only on infrastructure within the municipality, but also on surrounding land use, upstream runoff, and inter-municipal coordination.



The city faces changing flood-risk conditions. Khon Kaen's presentation shows that urban development has reduced permeable and water-retention areas, while land filling and construction in neighbouring urban areas have altered natural drainage patterns. Rainfall is also becoming more intense and localised, producing short-duration events that can quickly exceed conventional drainage capacity. As a result, the city must manage not only the volume of rainfall, but also the speed

at which runoff reaches canals, roads, and low-lying urban areas.

Khon Kaen has already developed a multi-strategy flood-management approach. Its earlier





measures include forecasting and warning systems, drainage infrastructure improvement, prevention and mitigation, and post-flood recovery. The municipality uses tools such as rainfall monitoring, warning thresholds, communication channels, drainage maintenance, community drain cleaning, evacuation arrangements, and recovery support. These efforts show that resilience is not built through one intervention, but through preparedness, infrastructure, operation, and institutional coordination.

The proposed direction is to strengthen these measures through connected urban green spaces and sponge-city thinking. Existing assets such as Bueng Kaen Nakhon, Bueng Thung Sang, canals, ponds, parks, and possible temporary retention areas can function as part of an integrated system to store, slow, regulate, and release stormwater. The city is also developing digital monitoring tools that show rainfall, lake water levels, drainage conditions, road-surface flooding, and warning levels. This provides a foundation for more evidence-based flood-risk management and future project preparation.



CHALLENGES

Khon Kaen's main challenges include intense short-duration rainfall, reduced infiltration, fragmented water systems, land-use pressure, and runoff from areas beyond the municipal boundary. The city also needs stronger coordination with neighbouring municipalities, clearer institutional arrangements, hydrological evidence, long-term maintenance planning, and financing for larger infrastructure, dredging, expansion, and possible diversion works.

.....



STRATEGIES

To address these challenges, the city has adopted several strategic approaches:

- Strengthening forecasting, rainfall monitoring, early warning, and emergency communication.
- Improving drainage infrastructure and maintaining existing canals and drainage networks.
- Using lakes, wetlands, parks, and public spaces as temporary water-retention areas.
- Exploring inter-municipal cooperation for shared water management across connected catchments.
- Developing digital tools to monitor rainfall, water levels, drainage systems, and road flooding.

**LESSONS**

Khon Kaen offers several lessons for cities developing connected blue-green infrastructure:

- Many cities already have ecological assets that can support flood resilience if managed as one system.
- Flood risk must be addressed beyond municipal boundaries and linked to catchment-level coordination.
- Early-warning systems and maintenance are as important as new construction.
- Digital monitoring can strengthen evidence-based planning and public communication.
- Sponge-city approaches require governance, financing, community participation, and long-term operation.

■ BEST PRACTICES



Sponge City planning and hydrological modelling for urban flood resilience

📍 Shanghai, China



Shanghai's Sponge City experience demonstrates how blue-green infrastructure can be embedded into a city-wide planning system rather than treated as isolated landscape improvement. As a global megacity of around 25 million people covering 6,341 square kilometres, Shanghai faces compound water-related risks from typhoons, intense rainfall,

high tides, upstream flooding, deteriorating water quality, and eutrophication. Its low-lying river-network polder landscape makes stormwater management a central issue for climate adaptation, urban safety, and long-term development.

The Sponge City approach responds to these pressures by combining blue-green



Photo credit: Shanghai Tongji Urban Planning and Design Institute (TJUPDI)

infrastructure, grey drainage infrastructure, and planning control. Its core principles are to absorb and infiltrate runoff, store and retain stormwater, filter and reuse rainwater, and safely discharge excess water.

In Shanghai, this approach is connected to wider international concepts such as Low Impact Development, Sustainable Drainage Systems, Water Sensitive Urban Design, green infrastructure, and nature-based



solutions, but it has been adapted into a planning-led and city-wide policy framework.

Implementation is supported through technical roadmaps, targets, indicators, rainfall analysis, hydrological modelling, and site-specific design strategies. The Pudong New Area example illustrates how Sponge City construction can be organised through a technical framework consisting of goals, strategies, and indicators, while the Lingang Area materials show the use of rainfall data and implementation systems to guide planning decisions. These tools help determine where particular measures should be applied and how they should be evaluated.

Practical measures include rain gardens, permeable pavement retrofitting, green roofs, dry creek restoration, terrain reshaping, vegetation planting, runoff pathway design, and maintenance planning. These interventions are intended to reduce local waterlogging, improve access to green and waterfront spaces, and mainstream Sponge City principles into planning and construction management. The case also highlights the growing use of digital tools, climate projections, and flood-risk mapping to translate future rainfall scenarios into site-specific planning decisions and climate-resilient infrastructure choices. This makes the approach relevant for cities seeking evidence-based adaptation pathways.



CHALLENGES

Shanghai's experience shows that implementation is complex in dense urban areas. Some indicators were overly ambitious for residential settings, while old urban districts faced limited space and complex stakeholder engagement. Maintenance responsibilities and lifecycle costs were sometimes underestimated. The case also shows that blue-green measures cannot work alone and must be combined with drainage and other grey infrastructure upgrades.



STRATEGIES

To address these challenges, Shanghai applied several strategies:

- Using hydrological analysis, modelling, and rainfall data to guide planning decisions.
- Developing technical roadmaps, targets, and indicators for implementation.
- Testing pilot projects before city-wide scaling.
- Combining source-control measures, ecological restoration, and integrated drainage design.
- Linking Sponge City planning with maintenance arrangements and performance evaluation.

**LESSONS**

Shanghai offers several lessons for cities developing Sponge City approaches:

- Sponge City planning should be treated as a system, not a collection of green projects.
- Targets must reflect local rainfall, land availability, and governance capacity.
- Digital modelling can support better site selection and risk assessment.
- Maintenance should be designed from the beginning, not added after construction.
- Performance should be evaluated after implementation before replication.

Wetland township development for flood resilience and biodiversity conservation

📍 Klang, Malaysia



The Royal City of Klang, governed by the Klang Royal City Council, is a historic urban centre and a major economic, logistics, and maritime hub in Selangor, Malaysia. Home to Port Klang, the city faces the challenge of managing rapid urban growth while maintaining environmental quality, social wellbeing, and economic

competitiveness. Klang's experience shows how nature-based solutions can be integrated into township planning, digital governance, and climate-resilience strategies rather than being treated as separate environmental projects.

Bandar Bukit Raja Wetland Townpark provides a practical

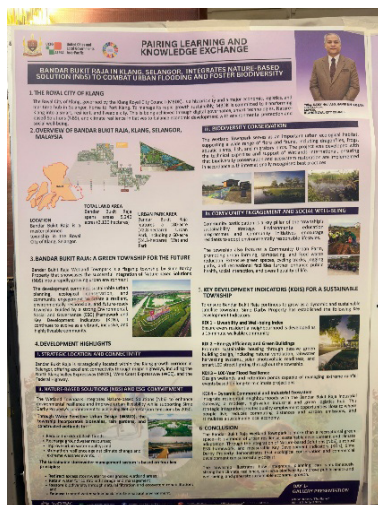


Photo credit: Klang Royal City Council

example of this approach. The township is located within the Klang growth corridor and covers approximately 5,240 acres. It includes a 180-acre urban park, within which a 60-acre wetland park functions as both a recreational landscape and flood-resilience infrastructure. The project demonstrates

how ecological conservation and commercial development public space and stormwater management can be integrated from the early stages of township planning.

The wetland townpark applies Water Sensitive Urban Design through bioswales, rain gardens,



constructed wetlands, retention ponds, and natural filtration systems. These features are designed to reduce flash-flood risks, recharge groundwater, improve urban water quality, and strengthen resilience to climate change and extreme weather. Its stormwater-management system follows four key principles: redirecting excess stormwater

to designated wetland areas, retaining water for controlled storage, restoring biodiversity through ecosystem rehabilitation, and releasing treated water safely back into the natural environment.

The project also reflects a broader township sustainability agenda. Biodiversity conservation is supported through wetland habitats for aquatic plants, fish, frogs, dragonflies, and migratory birds, with technical support from Wetlands International. Community engagement is encouraged through environmental education, a community urban farm, composting, food-waste reduction, cycling tracks, jogging paths, and recreational facilities. Key Development Indicators further link the township to liveability, green building, 100-year flood resilience, and a dynamic commercial and industrial ecosystem.



CHALLENGES

Klang's main challenge is balancing large-scale township development with the protection of ecological functions. Rapid urban expansion can increase runoff, reduce habitats, and intensify pressure on drainage systems. Ensuring that commercial development, biodiversity conservation, public access, stormwater performance, and long-term maintenance remain aligned requires strong coordination among local government, private developers, technical partners, and communities.



STRATEGIES

To address these challenges, Klang applied several strategies:

- Embedding wetland conservation within township planning from the early development stage.
- Applying Water Sensitive Urban Design through bioswales, rain gardens, and constructed wetlands.
- Using biodiversity restoration and ecological monitoring to strengthen environmental outcomes.

- Linking resilience with Environmental, Social, and Governance commitments and Key Development Indicators.
- Promoting community participation through urban farming, education, recreation, and green lifestyles.



LESSONS

Klang offers several lessons for cities integrating nature-based solutions into urban development:

- Wetlands can function as both flood infrastructure and public open space.
- Private-sector-led development can support resilience when guided by clear sustainability objectives.
- Water-sensitive design should be embedded before development locks in drainage problems.
- Biodiversity, recreation, and flood management can be planned as mutually reinforcing functions.
- Measurable indicators help connect sustainability commitments with implementation and accountability.

Heritage-sensitive climate adaptation through blue-green urban design

📍 Penang, Malaysia



Penang Island's experience shows how climate adaptation can be integrated into heritage conservation, land-use control, and people-centred urban design. The island covers approximately 319 square kilometres and has a population of around 792,000 people. More than 61 per cent of

Penang Island is covered by natural or green areas.

Development controls also protect environmentally sensitive areas: land above 75 metres from sea level is maintained as natural or green area, while development is restricted on steep slopes, water catchments, and forest reserve areas.



through greening and reducing flood risk through blue-green infrastructure.

A distinctive feature of Penang's approach is its ability to work within dense and heritage-sensitive urban environments. The programme includes tree-lined streets and connected canopies, pocket parks, green parking spaces, urban agriculture, and blue-green corridors. In George Town's UNESCO World Heritage Site, the North and East Seafront programme demonstrates how



nature-based climate adaptation zone can be introduced within a heritage-sensitive environment. The case shows that heritage areas are not barriers to climate action but places where climate-responsive design can be carefully integrated with conservation,

public-space improvement, and urban liveability.

Projects such as Union Square and the Beach Street Loop demonstrate how small and strategic urban spaces can be redesigned to reduce heat, manage stormwater, and improve public life. Technical features include climate-resilient tree selection, water features, permeable surfaces, and rooftop rainwater harvesting. These interventions combine aesthetic, ecological, and functional roles by supporting biodiversity, microclimate regulation, stormwater infiltration, reduced heat exposure, and more comfortable pedestrian environments.



CHALLENGES

Penang faces the combined challenge of rapid urbanisation, limited land availability, dense built-up areas, flash-flood risks, increasing urban heat, and heritage protection requirements. Implementing nature-based solutions in such contexts requires careful design, strong multi-agency coordination, community engagement, and long-term maintenance, especially where historic streets and public spaces must accommodate both conservation and climate adaptation.



STRATEGIES

To address these challenges, Penang applied several strategies:

- Protecting environmentally sensitive areas through land-use and development controls.
- Developing the Penang Nature-Based Climate Adaptation Programme as a flagship adaptation initiative.
- Using pocket parks, tree-lined streets, green parking, urban agriculture, and blue-green corridors.
- Applying permeable surfaces, rainwater harvesting, water features, and climate-resilient tree species.

- Using thermal imaging and site evidence to demonstrate cooling and climate-responsive design benefits.



LESSONS

Penang offers several lessons for cities working in dense or heritage-sensitive areas:

- Heritage conservation and climate adaptation can reinforce each other when planned carefully.
- Small urban spaces can deliver climate benefits when connected to a wider blue-green strategy.
- People-first design can reduce heat exposure and improve urban liveability.
- Technical evidence helps build support for nature-based urban interventions.
- Inclusive engagement is essential to ensure that climate adaptation leaves no one behind.

Integrated retention pond development as multifunctional blue-green infrastructure

📍 Banda Aceh, Indonesia



Jambi City, the capital of Jambi Province in central Sumatra, is located along the Batanghari River and functions as an administrative, commercial, educational, and service hub for the province. The city covers approximately 169.89 square kilometres and has a population of 627,774 inhabitants

across 11 districts and 68 urban villages. Its continued urban growth has increased pressure on drainage systems and low-lying areas, particularly as changing rainfall patterns contribute to recurring urban flooding.

The Jambi City Integrated Retention Pond Development



is a nine-hectare blue-green infrastructure project that seeks to move flood management beyond conventional drainage improvement. The project forms part of the Jambi Main Drainage Development and Revitalisation Programme and is scheduled for completion in November 2026. It combines flood mitigation, climate resilience, environmental protection, recreation, and local economic development within one multifunctional urban landscape.

The project responds to recurring flooding in the Asam River Basin, where existing flood-prone

areas cover approximately 194.14 hectares. Located in one of the lowest parts of the city, the retention pond works with the natural hydrology of the area by storing stormwater where it already tends to flow and accumulate. The project is expected to reduce flood-prone areas by around 115.45 hectares, equivalent to a 62.79 per cent reduction, while also creating green public space and improving environmental quality.

Implementation is supported through a blended funding mechanism. The Japan International Cooperation Agency

Beyond Flood Mitigation: Creating a Resilient, Green, & Prosperous Jambi - An Integrated Blue-Green Infrastructure Initiative
 Jember Kurniawan, Deputy Mayor of Jambi Government, Indonesia
 +62 953030254, jember@jember.go.id



Jambi City is the capital of Jambi Province, strategically located in central Sumatra along the Batanghari River. As the province's administrative, commercial, educational, and service hub, the city plays a critical role in regional economic growth while facing increasing climate-related challenges, particularly urban flooding caused by rapid urbanization and changing rainfall patterns.

City Profile		Project Overview	
Land Area	113.8 km ²	The Jambi City Integrated Retention Pond Development is a Jakarta Blue-green Infrastructure project that transforms flood management into a multi-functional public space, scheduled for completion in November 2026. It combines flood mitigation, climate resilience, environmental protection, recreation, and local economic development.	
Population	627,716 inhabitants		
Population Density	5,100 people/km ²		
Administrative Div.	22 districts & 68 urban villages		
Economic Growth	6.61%		
PMI	82.32 (High Category)		
Access Rate	1.05%		

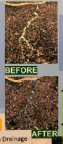
Project Background
 Recurring flooding in the Asem River Basin. Existing flood-prone areas cover 184.54 hectares. The Integrated Retention Pond Development was initiated to reduce flooding by 125.45 hectares while creating green public space, improving environmental quality, and supporting local economic growth through a blue-green infrastructure approach.

Implementation Process
 Under construction the Jambi Main Drainage Development and Revitalization Program, key activities include:
 Comparison of the project design, land acquisition for the first phase (3.3 hectares, plus 0.85 hectares of provincial government land donation), and ongoing construction and land acquisition for the remaining area. The main challenge:
 • Land acquisition (requiring compensation and legal status for farmers' lands)
 • Close cooperation among the National Government, ACA, Jambi Provincial Government, and Jambi City Government has been essential to address these issues and maintain project momentum.

Why NBS
 The retention pond is located in one of the lowest areas of Jambi City, where stormwater naturally flows and accumulates. By working with the natural hydrology, the project stores and gradually releases rainwater, reducing flood-prone areas by 82.78%.

Blended Funding Mechanism
 • ACA (on Japan International Cooperation Agency) through the Main Trunk Development and Revitalization Program for the construction of the retention pond and blue-green infrastructure.
 • National Government (Ministry of Public Works, Building, and Urban Planning Affairs).
 • Jambi City Government and Jambi Provincial Government funding for Phase 1 land acquisition.

Key Lessons
 • NBS approach flood management into a multi-benefit investment.
 • Strong multi-level collaboration has been essential to implementation.
 • The Integrated retention pond provides a suitable model that can be replicated in other green infrastructure, enhancing climate resilience, green space, and community well-being.



provides loan support for the construction of retention pond and drainage infrastructure. The national government, through the Ministry of Public Works, supports land acquisition for the second phase, while Jambi City Government and Jambi Provincial Government contribute to phase-one land acquisition and implementation support. This financing structure reflects the need for multi-level cooperation in large urban resilience projects.



CHALLENGES

Jambi's main challenge is land acquisition, particularly compensation and the legal status of riverbank land. The project also requires sustained coordination among the national government, the Japan International Cooperation Agency, Jambi Provincial Government, and Jambi City Government. Without legal clarity, social agreement, and institutional coordination, technically sound blue-green infrastructure projects can face delays during implementation.



STRATEGIES

To address these challenges, Jambi applied several strategies:

- Locating the retention pond in a naturally low-lying area where stormwater already accumulates.
- Combining flood mitigation with public space, environmental protection, and local economic development.
- Using blended funding from international, national, provincial, and municipal sources.
- Coordinating land acquisition and construction across multiple levels of government.

- Framing the project as blue-green infrastructure rather than a single-purpose drainage facility.



LESSONS

Jambi offers several lessons for cities developing multifunctional flood-resilience projects:

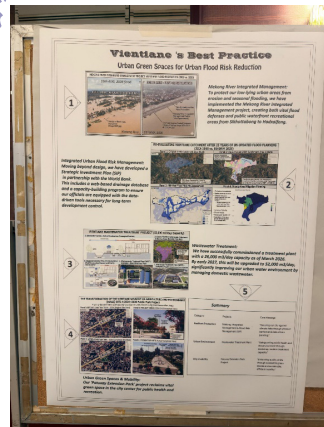
- Retention ponds can become public assets when designed beyond flood control.
- Working with natural hydrology can make urban water management more effective.
- Land acquisition and legal status should be addressed early in project preparation.
- Multi-level collaboration is essential for large blue-green infrastructure projects.
- Framing flood mitigation as a multi-benefit investment can strengthen political and financial support.



Integrated flood-risk, wastewater, and urban green-space management

 **Vientiane, Lao PDR**

Vientiane's experience shows how urban flood-risk reduction can be strengthened by connecting river management, drainage planning, wastewater treatment, and public green-space development. As a low-lying capital city along the Mekong River, Vientiane faces exposure to riverbank erosion,





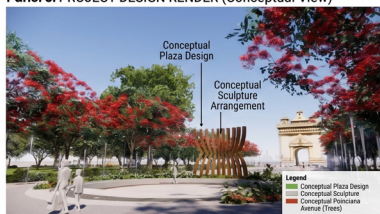
THE TRANSFORMATION OF THE VIENTIANE MINISTRY OF AGRICULTURE AND ENVIRONMENT (MA&E) SITE: A 2024–2026 Public Park Project

From a Government Compound to a Community Green Lung and Recreation Area

Panel 1: BEFORE CONSTRUCTION – 2024 (Original Site State)



Panel 3: PROJECT DESIGN RENDER (Conceptual View)



Panel 2: AFTER CONSTRUCTION – 2026 (Completed Site State)



Panel 4: PRESENT DAY SITE (Actual Completed View)



Photo credit: Vientiane City Government

seasonal flooding, drainage pressure, and urban water-quality challenges. Its approach demonstrates that flood resilience should not be treated as a single-sector issue, but as part of a broader urban water and liveability agenda.

The Mekong River Integrated Management project forms an important part of this approach. Developed to protect low-lying urban areas from erosion and seasonal flooding, the project combines flood defences with public waterfront recreational areas. The intervention covers sections from Sikhottabong to Hadxaifong and shows how river protection infrastructure can also improve public space and urban liveability when designed as part of the city's waterfront development.

Vientiane has also advanced integrated urban flood-risk management through a Strategic Investment Plan developed in partnership with the World

Bank. This includes a web-based drainage database and a capacity-building programme to equip municipal officials with data-driven tools for long-term development control. The use of drainage data is particularly important because it enables the city to better understand flood-prone areas, prioritise investments, and manage future urban expansion with stronger evidence.

In addition to flood-risk and drainage management, Vientiane is improving its urban water environment through wastewater treatment. A treatment plant with a capacity of 26,000 cubic metres per day was commissioned in March 2026, with an upgrade planned to reach 52,000 cubic metres per day by early 2027. The city also highlights the Patuxay Extension Park as an urban green-space and mobility project that reclaims central urban land for public health, recreation, and improved quality of life.



CHALLENGES

Vientiane faces several connected challenges: protecting low-lying areas from seasonal flooding and erosion, improving drainage performance, managing domestic wastewater, and ensuring that urban growth does not increase future flood exposure. Strengthening municipal capacity, maintaining reliable data systems, and coordinating infrastructure, water management, and public-space planning are essential for long-term resilience.

.....



STRATEGIES

To address these challenges, Vientiane applied several strategies:

- Integrating Mekong River flood protection with waterfront public-space development.
- Preparing a Strategic Investment Plan for urban flood-risk management.
- Developing a web-based drainage database to support data-driven decision-making.
- Expanding wastewater treatment capacity to improve the urban water environment.
- Reclaiming central urban green space through the Patuxay Extension Park.



LESSONS

Vientiane offers several lessons for cities linking flood resilience and urban water management:

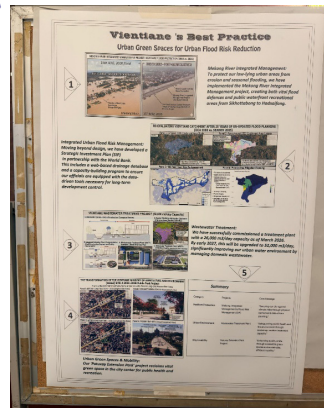
- Flood protection can also improve public space when designed as part of waterfront development.
- Drainage databases help cities move from reactive responses to evidence-based investment planning.
- Wastewater treatment should be connected to wider flood-risk and environmental management.
- Urban parks can support public health while contributing to a more liveable city.
- Resilience improves when engineering, data systems, capacity building, and green space are planned together.



Heritage-city resilience through integrated urban management

 **Luang Prabang, Lao PDR**

Luang Prabang's experience shows that urban flood resilience cannot be separated from heritage protection, tourism management, infrastructure improvement, and inclusive urban governance. The city covers approximately 761 square kilometres and has a population of around 100,300 people.



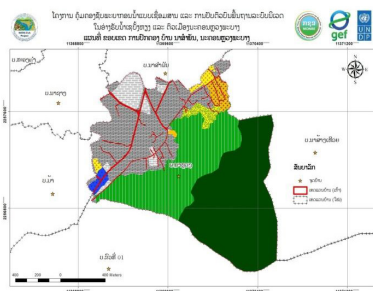
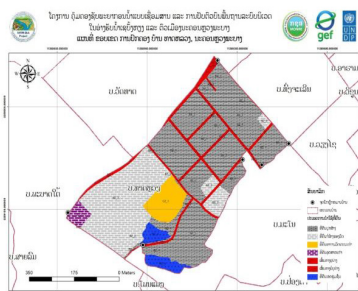


Photo credit: Luang Prabang Head of Agriculture and Environment Office

As the centre of Luang Prabang Province and the northern region of Lao PDR, it is also a UNESCO World Heritage Site, an international tourism destination, a member of the ASEAN Smart Cities Network, and a city with friendship-city relationships with 19 foreign cities.

The city faces several urban challenges that directly affect resilience and liveability. These include untreated wastewater discharge, traffic congestion, unsafe streets, overcrowded tourist sites, uncontrolled urban growth, and the risk of heritage loss. These pressures are especially significant because Luang Prabang's built, natural, and intangible heritage is central to its identity and economy. Managing growth therefore requires the city to protect its environmental and cultural assets while improving basic urban services.

Luang Prabang's Smart and Integrated Urban Strategy provides a framework for responding to these pressures. Supported by the ASEAN-Australia Smart Cities Trust Fund, the strategy sets a vision of becoming a liveable heritage city for all and a vibrant, sustainable tourism destination that highlights and supports local

communities, cultural heritage, and the natural environment. Its approach connects integrated tourism and heritage, clean and safe environments, sustainable villages, 15-minute city planning, spatial planning, governance, data management, and gender equality, disability, and social inclusion.

The city is also supported by the Urban Environment Improvement Investment Project, financed through loans and grants from the Asian Development Bank. The project aims to improve the quality and coverage of urban infrastructure and services, strengthen institutions and capacity for climate and disaster-resilient development, promote inclusive and gender-responsive urban management and tourism, and enhance women's leadership and economic empowerment. This shows how resilience in a heritage city requires both physical investment and institutional strengthening.



CHALLENGES

Luang Prabang's main constraints are systemic. The city faces limited funding, lack of guidelines for concessions and management contracts, weak planning and enforcement, fragmented decision-making, lack of coordination, inadequate mainstreaming of gender equality, disability, and social inclusion, and limited institutional capability. These constraints make it difficult to translate resilience plans into coordinated and sustained implementation.

.....



STRATEGIES

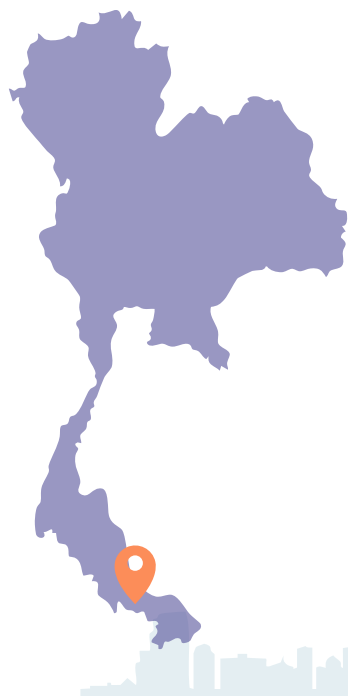
To address these challenges, Luang Prabang applied several strategies:

- Linking smart-city planning with heritage protection, tourism management, and environmental improvement.
- Using integrated urban strategy to connect spatial planning, governance, data, and inclusion.
- Improving wastewater, mobility, infrastructure, and environmental services through investment projects.
- Strengthening climate and disaster-resilient urban development pathways.
- Promoting inclusive and gender-responsive urban management and tourism.

**LESSONS**

Luang Prabang offers several lessons for heritage and tourism cities:

- Resilience must be integrated with heritage, tourism, infrastructure, and environmental protection.
- Climate adaptation in heritage cities requires careful planning, not standardised infrastructure transfer.
- Institutional capacity and enforcement are as important as physical investment.
- Inclusion should be mainstreamed into urban resilience and tourism management.
- Smart-city tools are most useful when connected to governance, planning, and local community needs.



Hybrid flood management through the Kaem Ling water-retention approach

 **Hat Yai, Thailand**

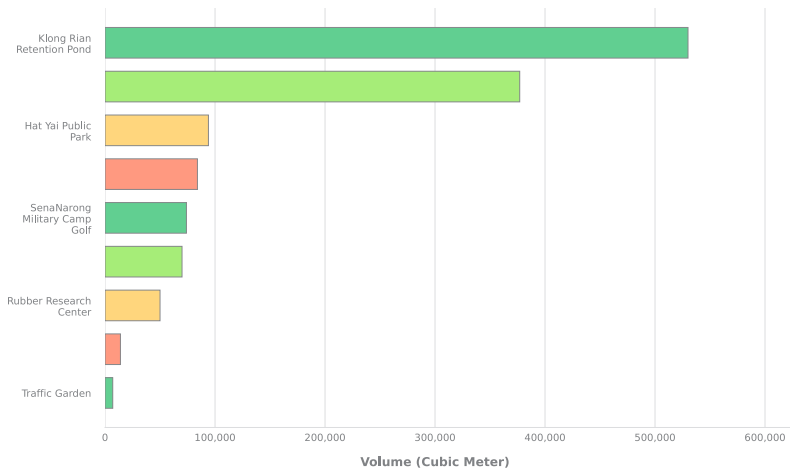
Hat Yai's experience demonstrates how a city can reduce flood risk by combining engineering, nature-based solutions, early warning, and community preparedness. Located in Songkhla Province in southern Thailand, Hat Yai is a major economic and transport hub with nearly 160,000 residents and

a floating population more than double that number. Its low-lying floodplain location makes the city highly vulnerable to intense rainfall, river overflow, and rapid urban runoff.

Major floods in 2000 and 2010 became turning points for the municipality. The 2000 flood caused severe economic and

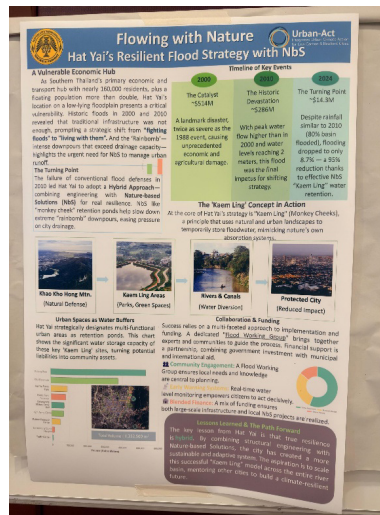


Photo credit: Hat Yai City Municipality



agricultural damage, while the 2010 flood, with high peak water flow and water levels reaching around two metres, showed that conventional flood-defence systems were not sufficient. These events pushed Hat Yai to shift from “fighting floods” toward “living with them,” using a hybrid approach that combines grey infrastructure with nature-based water-retention systems.

At the centre of this approach is the Thai Kaem Ling, or “monkey cheek,” concept. The



principle uses natural and urban landscapes to temporarily store excess floodwater during heavy rainfall and release it gradually when downstream systems have capacity. Parks, green spaces, reservoirs, canals, and other designated retention areas function as water buffers, reducing pressure on drainage infrastructure while maintaining public and ecological value.

Hat Yai has designated several multi-functional retention

sites, including areas such as Prince of Songkla University Reservoir, Public Park Nursery, 42nd Army Circle, Senanarong Camp Hospital, and Khlong Rian. Together, these sites provide significant temporary water-storage capacity. During a recent extreme rainfall event, flood impacts were substantially reduced compared with earlier disasters, showing how retention landscapes can help cities absorb extreme rainfall while reducing downstream risk.



CHALLENGES

Hat Yai continues to face risks from intense rainfall, urban expansion, low-lying geography, and increasing impermeable surfaces. Rainbomb events can exceed drainage capacity, while development pressure reduces natural absorption areas. Sustaining the system also requires coordination among municipal departments, technical experts, communities, and agencies responsible for drainage, land use, water management, and emergency preparedness.



STRATEGIES

To address these challenges, Hat Yai applied several strategies:

- Applying the Kaem Ling concept by using parks, reservoirs, canals, and green spaces as temporary floodwater storage areas.
- Combining conventional engineering with nature-based solutions and watershed management.
- Strengthening early-warning systems through real-time water-level monitoring.
- Establishing a Flood Working Group involving experts and communities.
- Using blended finance to support both large-scale infrastructure and local nature-based interventions.

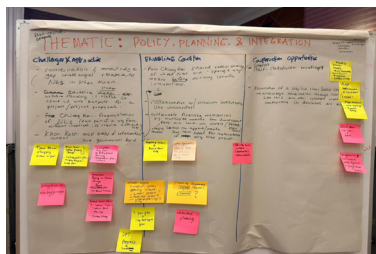
**LESSONS**

Hat Yai offers several lessons for cities facing recurrent urban flooding:

- Hybrid systems are more adaptive than relying only on structural flood defences.
- Urban open spaces can serve both recreational and flood-retention functions.
- Nature-based solutions work best when linked to early warning and community preparedness.
- Watershed-level thinking is essential for managing flood risks across urban and upstream areas.
- Successful retention models can be scaled across river basins when supported by cooperation and financing.

KEY LESSONS

Across the city experiences, one common lesson emerged: connected blue-green infrastructure is most effective when planned as part of a wider urban system. The cases show that flood resilience depends not only on physical infrastructure, but also on planning, governance, reliable data, sustainable financing, maintenance, and community participation. Wetlands, parks, lakes, canals, green corridors,



retention ponds, and public spaces can reduce flood risk when they are connected and managed as functional climate infrastructure.



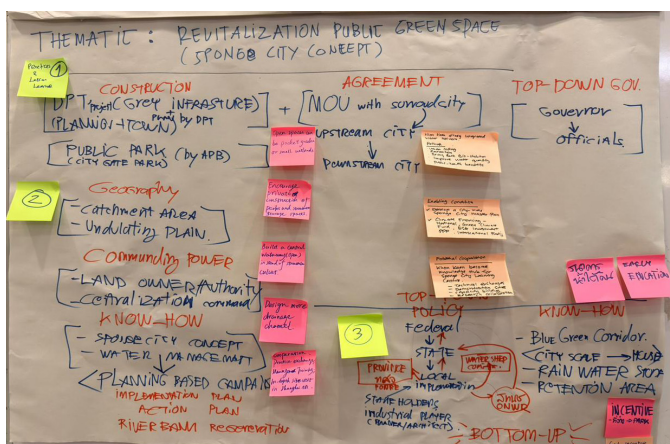
Blue-green infrastructure should be planned as a connected system

Urban flood resilience cannot rely on isolated ponds, parks, drains, or greening projects. Cities need to understand how water moves across catchments, neighbourhoods, canals, lakes, wetlands, and public spaces. When these assets are planned as one system, they can slow runoff, store stormwater, reduce pressure on drainage infrastructure, and create wider benefits for cooling, biodiversity, recreation, and public wellbeing.



Hybrid grey and blue-green systems are more resilient

Nature-based solutions do not replace conventional infrastructure. The strongest approaches combine drainage, embankments, pumps, wastewater systems, early-warning mechanisms, wetlands, retention areas, and permeable landscapes. Hybrid systems allow cities to manage flood risk more flexibly, especially where rainfall is becoming more intense and urban development has reduced natural absorption capacity.





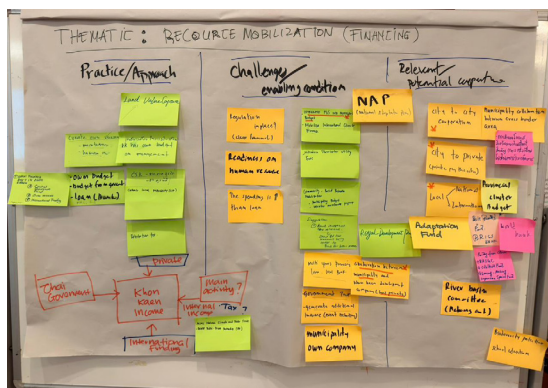
Evidence, modelling, and monitoring strengthen implementation

Cities need reliable data to move from broad ideas to practical projects. Rainfall analysis, hydrological modelling, drainage databases, water-level monitoring, thermal imaging, and flood-risk mapping help cities identify priority sites, test design options, and communicate benefits. Evidence also makes it easier to prepare investment-ready proposals and justify public or external financing.



Governance and financing determine whether projects can scale

Blue-green infrastructure cuts across planning, public works, environment, water management, parks, finance, land administration, and community development. Without clear institutional roles, coordination mechanisms, maintenance budgets, and financing strategies, projects may remain small pilots. Cities need to link blue-green infrastructure to official plans, capital investment pipelines, climate strategies, and long-term operation and maintenance arrangements.





Public spaces and communities are part of flood resilience

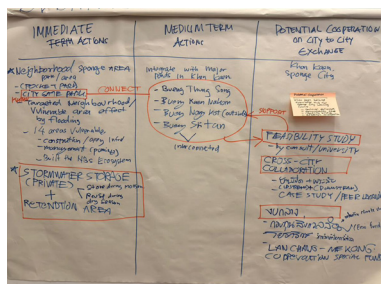
Parks, waterfronts, streets, urban farms, heritage areas, and neighbourhood green spaces can function as climate infrastructure while improving daily urban life. Community participation is essential for maintenance, preparedness, environmental awareness, and local stewardship. Flood resilience becomes more sustainable when residents understand that green and water spaces are not decorative elements, but shared assets that protect the city.

THE WAY AHEAD



The experiences presented in this Learning Note point to a clear direction for Asia-Pacific cities: urban flood resilience must move from fragmented interventions towards connected systems. Wetlands, lakes, canals, parks, retention ponds, drainage networks, public

spaces, streets, and communities should no longer be treated as separate components of urban development. When planned together, they can form a blue-green infrastructure network that reduces flood risk while improving biodiversity, public health, water quality, urban cooling, recreation, and liveability.



The way ahead is not simply to build more infrastructure, nor to replace conventional drainage systems with nature-based solutions. Cities need hybrid approaches that combine engineered systems with ecological functions and community-based stewardship. Drains, pumps, embankments, wastewater systems, early-warning mechanisms, wetlands, parks, retention areas, and permeable landscapes each have a role to play. The challenge is to connect them through planning, governance, financing, and long-term operation.

First, cities need to recognise existing blue-green assets as functional climate infrastructure. Many cities already have wetlands,

lakes, rivers, canals, vacant land, agricultural areas, parks, and public open spaces that can support flood regulation. However, these assets are often underused, fragmented, or viewed mainly as beautification, recreation, or leftover land. Once urban development converts these spaces into hard surfaces, restoration becomes more difficult and expensive. Protecting and connecting existing assets early is therefore a practical and cost-effective strategy for long-term resilience.

Second, blue-green infrastructure should be integrated into spatial planning, infrastructure pipelines, climate strategies, and annual investment processes. Projects are more likely to move beyond pilot stage when they are embedded in formal city plans and linked to municipal budgets. This means identifying where water flows, where flooding occurs, where green and open spaces remain, which communities are most vulnerable, and which agencies are responsible for



action. Without this planning foundation, nature-based solutions risk becoming isolated projects with limited influence on the wider urban system.

Third, cities need stronger technical evidence to support decision-making. Rainfall data, hydrological modelling, drainage mapping, flood-risk assessment, land-use analysis, water-level monitoring, and economic assessment are essential for determining which interventions are feasible and where they should be located. Evidence helps cities avoid transferring water from

one vulnerable area to another. It also supports the preparation of investment-ready proposals, especially where projects require national funding, climate finance, development-partner support, or blended financing.

Fourth, implementation should be phased. Cities do not need to begin with large and expensive projects. Smaller interventions such as pocket parks, constructed wetlands, permeable pavements, green streets, urban agriculture, vacant-land retention areas, and upgraded public spaces can demonstrate the value of

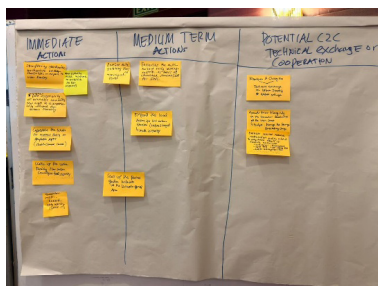
blue-green infrastructure. These visible pilots can build public understanding, test technical approaches, generate local evidence, and strengthen political support. Over time, they can be connected into larger wetland, park, canal, and watershed systems.

Fifth, governance arrangements must be strengthened. Urban flood risk does not follow administrative boundaries. Water flows across neighbourhoods, municipalities, catchments, infrastructure systems, and land-use zones. Cities therefore need coordination between planning, public works, environment, water management, parks, finance, land administration, disaster management, and community-development departments. They also need cooperation with neighbouring municipalities, provincial authorities, river-basin organisations, universities, national agencies, private landowners, and community groups. Clear mandates, shared data, technical guidelines, and operating procedures are

necessary to avoid fragmented implementation.

Sixth, financing must be realistic and implementation-oriented. Blue-green infrastructure creates multiple benefits, but these benefits are often not fully reflected in conventional infrastructure budgets. Cities should quantify avoided flood damage, reduced pressure on drainage systems, improved water quality, lower heat exposure, biodiversity benefits, public-health value, tourism potential, recreation value, and local economic opportunities where possible. This evidence can strengthen budget proposals and funding applications. Financing strategies should also cover operation and maintenance, not only initial construction. Without maintenance budgets, even well-designed projects can lose their function over time.

Seventh, communities should be involved throughout the full project cycle. Residents are not only beneficiaries of flood-resilience projects; they are also



sources of local knowledge and potential stewards of blue-green infrastructure. Community participation can support site selection, local monitoring, maintenance, early warning, waste reduction, waterway protection, urban farming, and preparedness during extreme rainfall. Youth groups, schools, neighbourhood organisations, businesses, and vulnerable communities should be engaged not only through consultation, but through practical mechanisms that allow them to contribute to implementation and long-term care.

Eighth, peer learning should continue as an adaptive process. The city experiences in this Learning Note show that there is no single model of blue-green

infrastructure that can be copied directly from one place to another. Shanghai's Sponge City planning, Klang's wetland township, Penang's heritage-sensitive climate adaptation, Jambi's integrated retention pond, Vientiane's urban water-management system, Luang Prabang's heritage-city strategy, Hat Yai's Kaem Ling approach, and Khon Kaen's connected wetlands and parks all respond to different ecological, institutional, financial, and social conditions. The value of peer learning lies in understanding why each approach was selected, how it was implemented, and what enabling conditions were required, before adapting relevant elements to local realities.

For Khon Kaen and other participating cities, the immediate task is to translate learning into action. This includes mapping blue-green assets, clarifying institutional responsibilities, compiling baseline data, engaging vulnerable communities and young people, reviewing existing plans, and identifying where nature-based solutions can be

formally integrated. Medium term actions include strengthening multi-hazard early-warning systems, undertaking hydrological and feasibility studies, expand successful pilots, prepare city-wide blue-green infrastructure frameworks, develop shared water-management guidelines with neighbouring jurisdictions, and prepare investment-ready project proposals.

The future of urban flood resilience in Asia and the Pacific will depend

on whether cities can work with water rather than only trying to remove it. This requires a shift in mindset: water bodies, wetlands, parks, canals, streets, and public spaces are not separate urban elements, but parts of a living infrastructure system. The resilient city of the future will be one that plans, finances, governs, and maintains this system carefully, allowing nature, infrastructure, and communities to work together.





Regional
Learning Note

#4

Enhancing Urban Resilience through Connected Urban Green Spaces for Urban Flood Risk Reduction:

A Pilot Initiative in Khon Kaen City

