**Siem Riep, Cambodia**
Regional Capacity Development Technical Assistance
Train-the-Trainers for Cambodia and Lao PDR
27 November to 1December, 2017

# Building Resilience and Sustainability in the GMS

## TA-8186: Climate Resilience in Cities

**Asian Development Bank (ADB)**
**International Center for Environment Management (ICEM)**
**Nordic Development Fund (NDF)**

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**Sr. Advisor in the office of Vice President**
**for Knowledge Management**

# Partnership Objectives : 3 GMS Sister Towns:

- Battambang , Cambodia - flood and drought-prone watershed in Tonle Sap basin
- Dong Ha, Vietnam - typhoon-prone coastline city threatened by sea level rise, storm surge and flash flooding
- Kaysone Phomvihane, Lao - frequent extreme flooding along the Mekong River

- **Leverage** partnerships to optimize competitive advantage – Technical, Financial and Country Engagement.
- **Extend** to policy shifts, innovations in planning, design and implementation together with training and capacity building.
- **Advance** the adaptation network between cities
- **Scale up** effective solutions through demonstration impact.
- **Develop** learning tools


Source : ADB. 2017. Nature Based Solutions for Building Resilience in Towns and Cities: Case Studies from the Greater Mekong Sub-region
Under this TA, ICEM utilized the climate change adaptation and mitigation (CAM) methodology developed by them and tested for over five years in ten countries - Viet Nam, Cambodia, Lao PDR and Thailand, as well as the greater Asia-Pacific Region including Nepal, Fiji, Marshall Islands, Pacific Islands, Palau, Solomon Islands and Timor Leste

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# "Train the Trainers" for climate change adaptation in three Greater Mekong Sub-Region sister towns





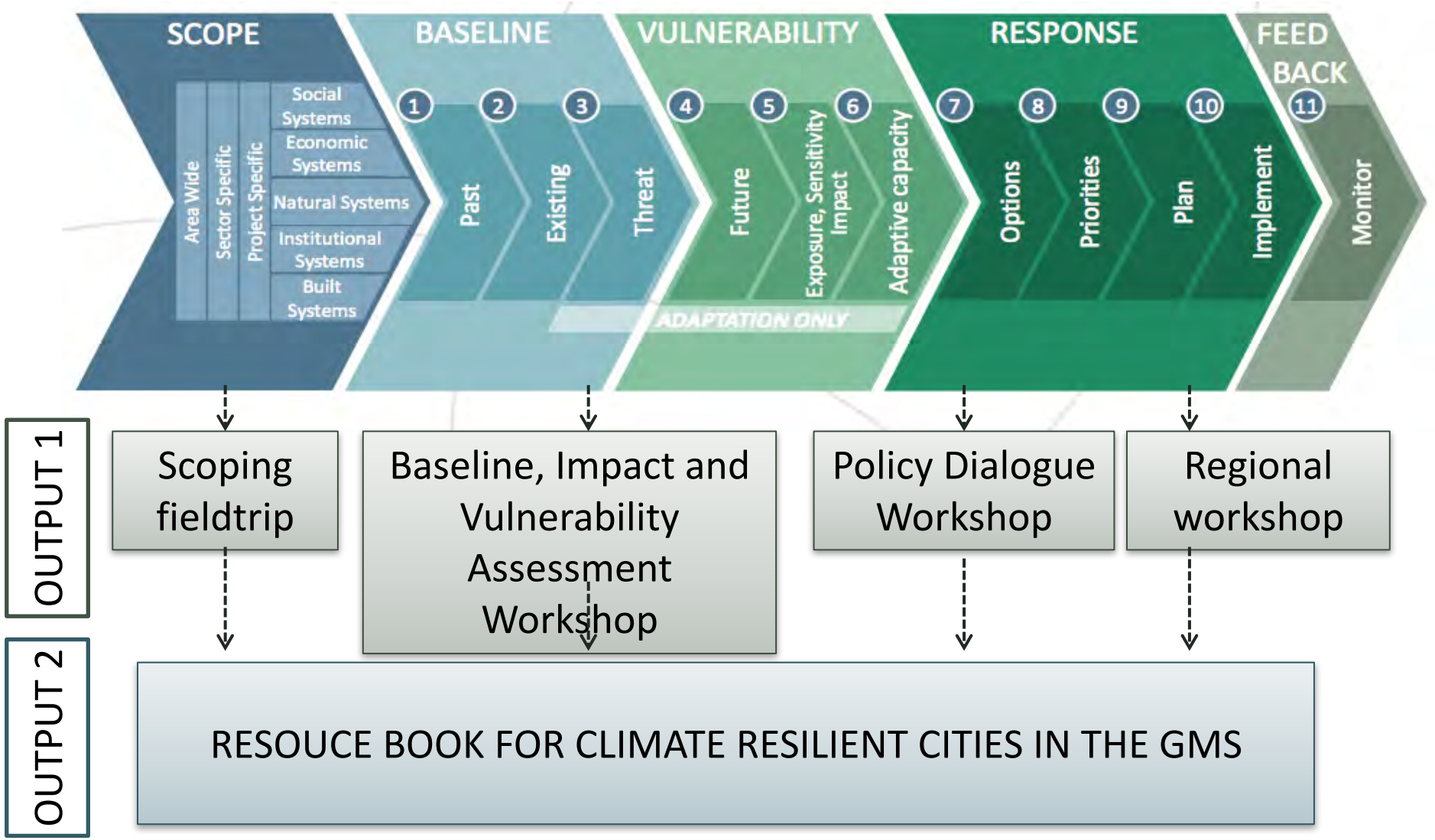
**Climate change core groups:** 100 local government experts from a broad range of line agencies, NGOs and private sector

Source : ADB. 2017. Nature Based Solutions for Building Resilience in Towns and Cities: Case Studies from the Greater Mekong Sub-region

# Technical Assistance Areas


1. **Develop methods** for assessing climate change and vulnerability impacts
2. **Assess the** *impacts* of climate change, overlay **climate change data** on town plans and assess adjustments, record data, on specific flood protection and drainage infrastructure
3. **Develop adaptation measures** to address impacts
4. **Institutional mechanisms** for preparing and implementing adaptation plans and technical measures for wider replication.
5. **Integrating** green infrastructure principles into infrastructure policy, planning and design.

# Vulnerability assessment – Adaptation planning methodology

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# Core Group Participatory Mapping- Identify hot spots

- Identified the locations, boundaries, duration, and depth of past floods
- Then estimated the additionality of climate change

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# Strategic infrastructure case studies

| | |
|---|---|
| Battambang | • Railway yard<br>• Irrigation canal<br>• River embankments |
| Kaysone | • Flood gates and canal<br>• Market and drainage system |
| Dong Ha | • Port<br>• Market and drainage system<br>• Box canal drainage system |

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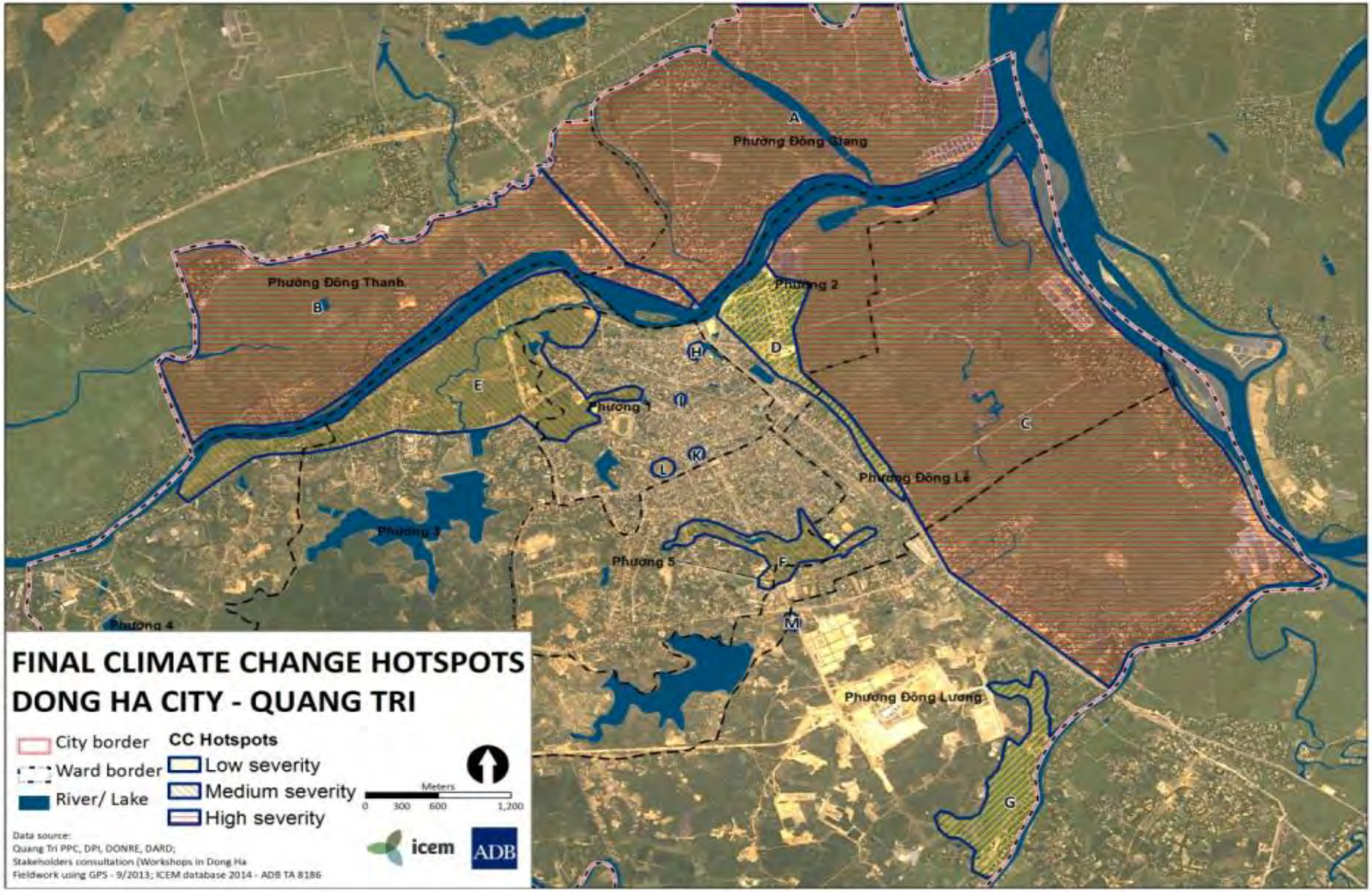
# The development and green infrastructure interface

Source : ADB. 2015. *Nature Based Solutions for Sustainable and Resilient Mekong Towns, Volume 1 of the Resource Kit for Building Resilience and Sustainability in Mekong Towns*. Prepared by ICEM

| | Bridges | Buildings | Canals | Commercial area redevelopment | Culverts and drains | Dykes | Drainage | Flood gates | Industrial areas | Markets | Parking areas | Port redevelopment | Residential areas | River embankments | Road embankments | Roads and footpaths |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bioretention pond | | ■ | | ■ | | | ■ | | ■ | ■ | ■ | ■ | ■ | | | ■ |
| Bioswales | | ■ | | ■ | | | ■ | | ■ | ■ | ■ | ■ | ■ | | | ■ |
| Brush mattress | ■ | | ■ | | ■ | ■ | | ■ | | | | | | ■ | ■ | |
| Constructed wetlands | | | | ■ | | | ■ | | ■ | ■ | | | ■ | | | |
| Drainage corridors | | | ■ | | | | ■ | | | | | | | | | |
| Greywater recycling | | ■ | | ■ | | | | | ■ | ■ | | ■ | ■ | | | |
| Green roofs and walls | | ■ | | ■ | | | ■ | | ■ | ■ | | ■ | ■ | | | |
| Live crib wall | ■ | | ■ | | | ■ | ■ | | ■ | | | | | | ■ | ■ |
| Live fascines | ■ | | ■ | | | ■ | ■ | | ■ | | | | | | ■ | ■ |
| Live fencing | ■ | | ■ | | | ■ | ■ | | ■ | | | | | | ■ | ■ |
| Live staking | ■ | | ■ | | | ■ | ■ | | ■ | | | | | | ■ | ■ |
| Log terracing | ■ | | ■ | | | ■ | ■ | | ■ | | | | | | ■ | ■ |
| Palisades | ■ | | ■ | | | ■ | ■ | | ■ | | | | | | ■ | ■ |
| Permeable paving | | | | ■ | | | ■ | | ■ | ■ | ■ | ■ | ■ | | | ■ |
| Rain gardens | | ■ | | ■ | | | ■ | | ■ | ■ | ■ | | ■ | | | |
| Solid waste management | | ■ | | ■ | | | ■ | | ■ | ■ | | ■ | | | | |
| Stormwater tree pits | | ■ | | ■ | | | ■ | | ■ | ■ | ■ | | ■ | | | ■ |
| Urban river terracing | | | ■ | ■ | | | | | | | | | | | ■ | |
| Urban tree canopy cover | | ■ | | ■ | | | | | ■ | ■ | ■ | ■ | | | | ■ |
| Vegetated gabions | | | ■ | | ■ | ■ | | ■ | | | | | | ■ | ■ | |
| Vegetated eotextiles | ■ | | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Vegetated revetment | | | ■ | | ■ | ■ | | ■ | | | | | | ■ | | |
| Vegetated riprap | | | ■ | | ■ | ■ | | ■ | | | | | | ■ | | |
| Vetiver grass | ■ | | ■ | | ■ | | ■ | ■ | ■ | | | ■ | ■ | ■ | | |
| GREEN INFRASTRUCTURE | | | | | | | | | | | | | | | | |


A
Phường Đông Giang
Phường Đông Thanh
B
Phường 2
D
H
E
Phường 1
I
C
K
L
Phường Đông Lễ
Phường 3
Phường 5
F
M
Phường 4
Phường Đông Lương
G
FINAL CLIMATE CHANGE HOTSPOTS
DONG HA CITY - QUANG TRI
City border
Ward border
River/ Lake
CC Hotspots
Low severity
Medium severity
High severity
Meters
0 300 600 1,200
Data source:
Quang Tri PPC, DPI, DONRE, DARD;
Stakeholders consultation (Workshops in Dong Ha
Fieldwork using GPS - 9/2013; ICEM database 2014 - ADB TA 8186
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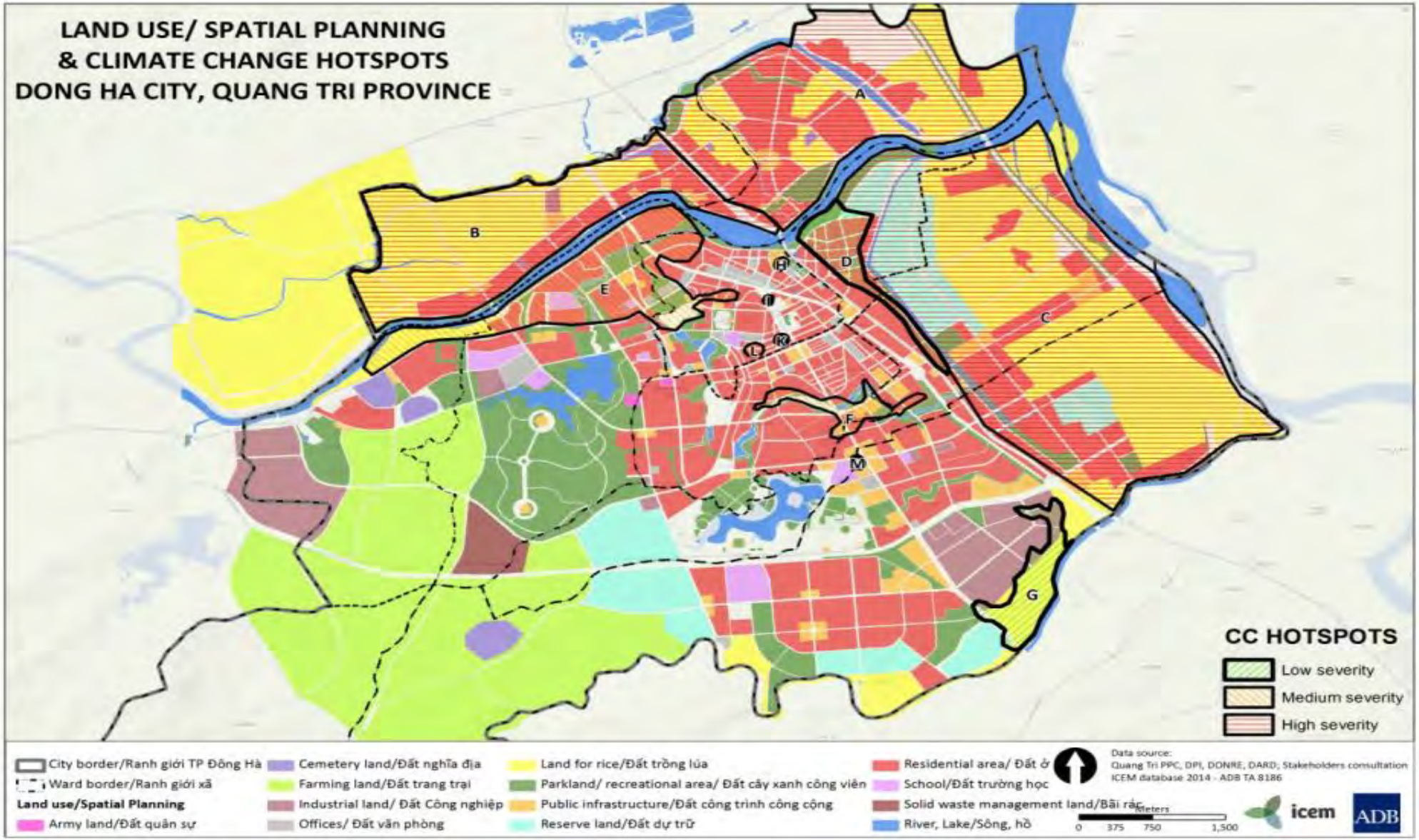


- Overlaying the hotspots on town zoning scheme
- Many new developments are planned for zones with a high risk of climate-related disasters.

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# Proposed changes to master plan and safeguards for hot spot areas

- **Zone boundary adjustments:** Modify zone boundaries to reflect hot spots
- **Restrict permitted land uses:** in hot spot areas, with no critical facilities built.
- **Environment protection zones:**
  - Define the zone as a storm water retention and drainage area.
  - Make clear regulations for the protection of natural systems
  - No development permitted
- **Design standards** to promote green infrastructure / bioengineering in these areas.
- **Social safeguards:**
  - Increase participation of community in conserving of nature through communal agreements.
  - Aim to prevent the most vulnerable, poor inhabitants from settling in vulnerable areas by providing alternative low-cost land elsewhere.

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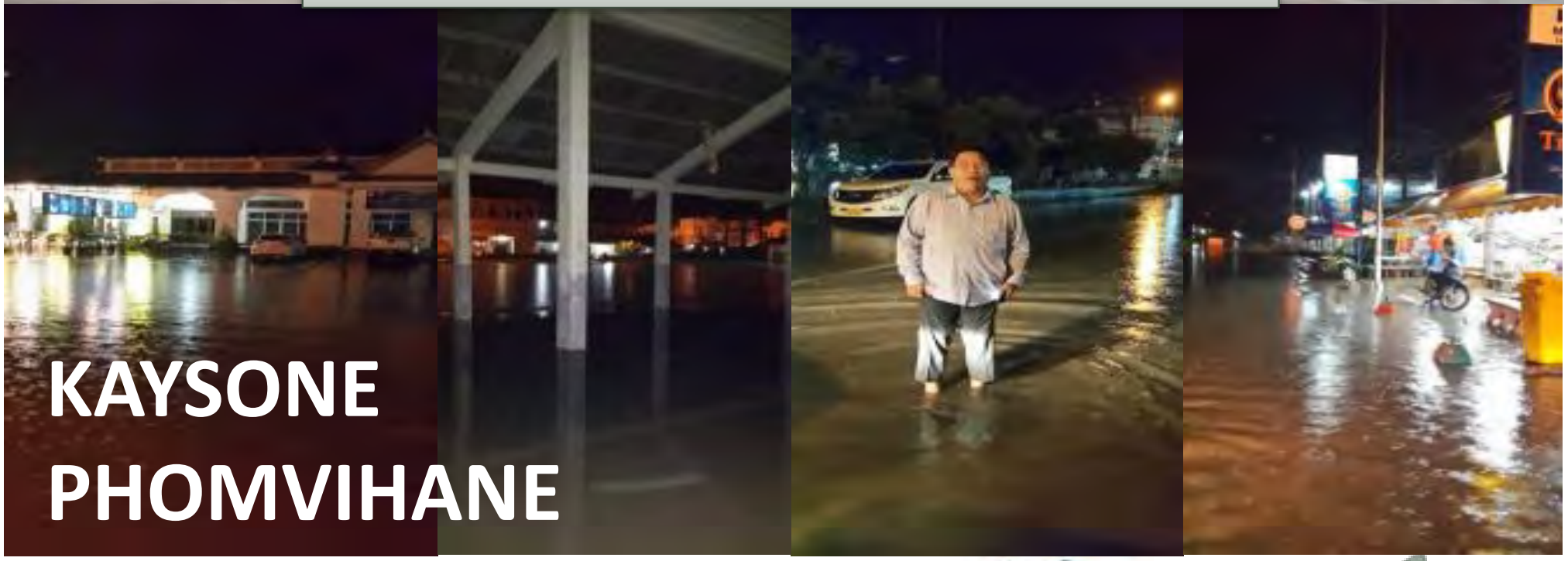
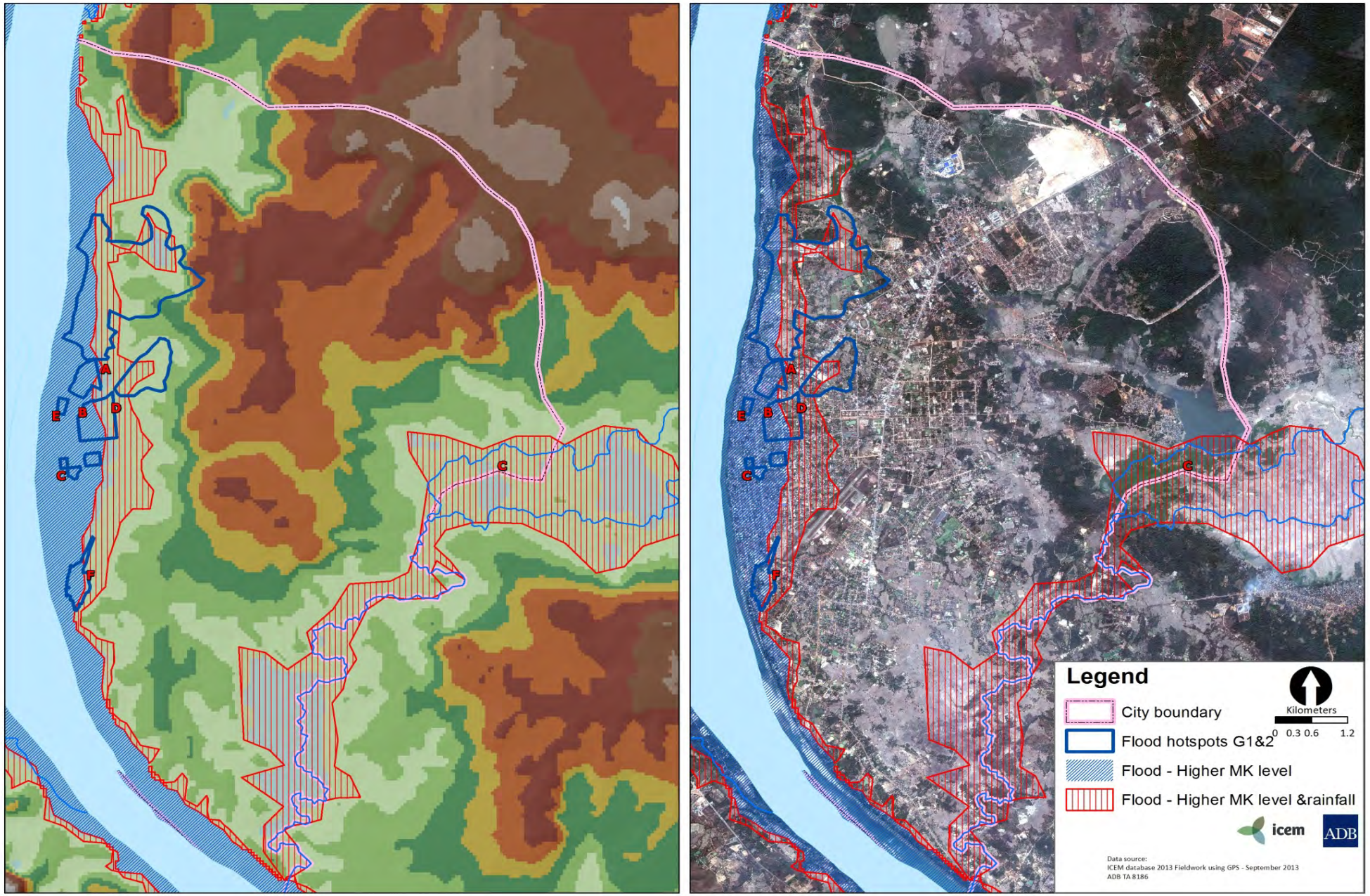
# Kaysone - Existing climate conditions and recorded extreme events

Pooling flood in Old market area, Senna Rd , 2011




Pooling flood in Old market area, Senna Rd, 18/9/2013

# Flood risk areas overlaid with potential extreme river and rainfall impacts of climate change

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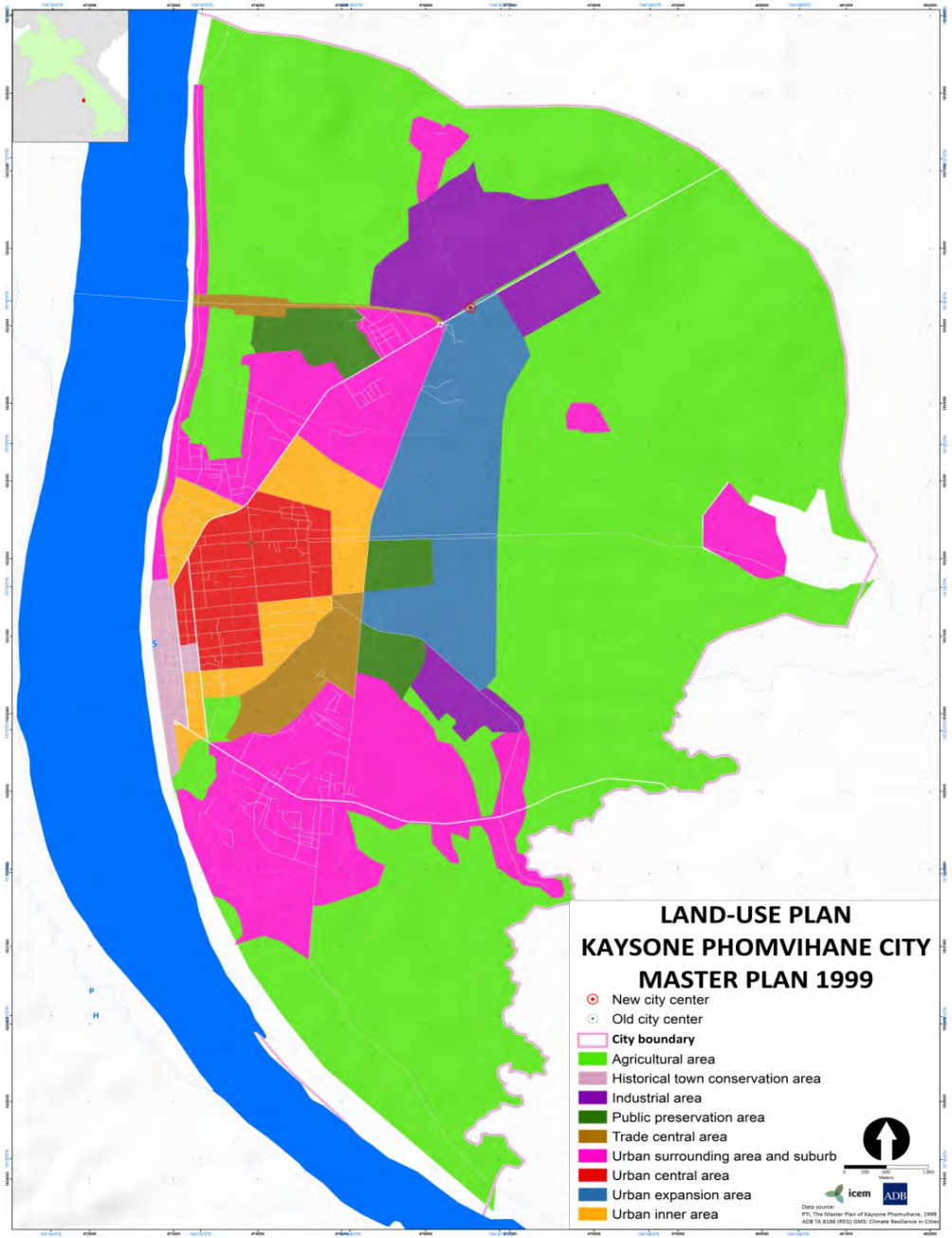
# Master plan of Kaysone Phomvihane-Land Use zoning

| Zone | Description of Zone | Areas (hectares) |
|---|---|---|
| UAa | Historical town conservation zone | 55.41 |
| Ua | Urban central zone | 259.87 |
| Ub | Urban inner zone | 229.45 |
| Uc | Urban Surrounding Zone and suburb | 1,096.7 |
| A | Trade central zone | 260.75 |
| I | Industrial zone | 415.66 |
| Ncb | Public preservation zone | 276.65 |
| Nca | Agricultural zone | 3,666.385 |
| Na | Urban expansion zone | 739.625 |
| | **Total** | **7,000.00** |




Source: PTI, The Master Plan of Kaysone Phomvihane, 1999.

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# Zone safeguards for climate change

| Zone ID | Type of safeguard | Description of safeguard |
|---|---|---|
| Heritage zone | Rehabilitate and protect old buildings | Re-demarcate the area, develop regulations, organize responsible committee with local participation, build the area as an ecotourism |
| Preservation (extreme flood) zone | Reserve the area for public space and recreation | No construction allowed |
| Peri-urban zone | Reserve the area for future city expansion with nature based approaches | Define forest protection areas and apply bioegineering safeguards for all development |
| Natural drainage zone | Retain and rehabilitate natural drainage corridors | Apply bioegineering safeguards and approaches to all drainage infrastructure. |

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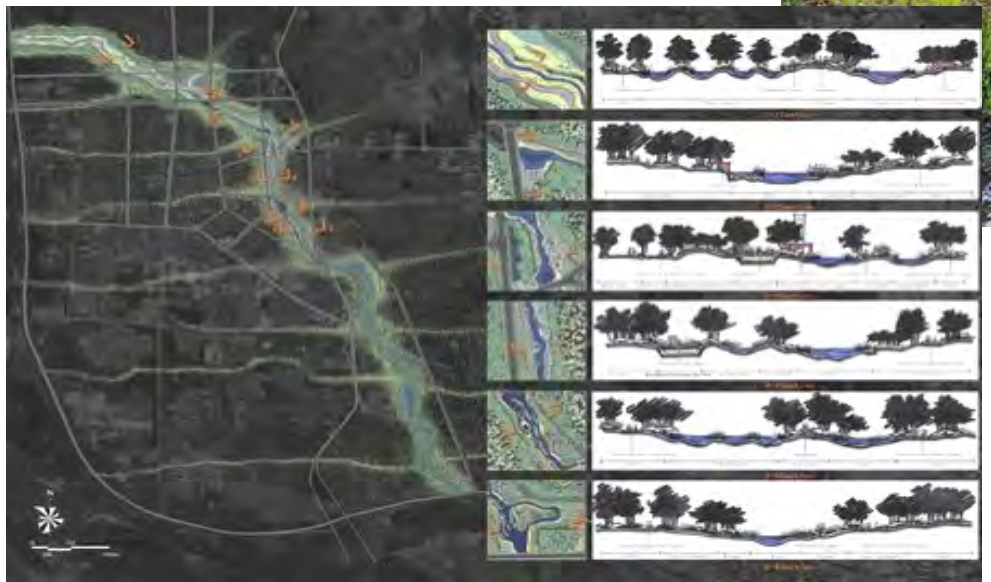
# Recreate natural drainage corridors

Natural drainage corridors – establish, rehabilitate and mimic networks of natural draining systems throughout the town



# Urban Tree Canopy

Setting tree canopy goals to restore some of the benefits provided by trees.


Trees reduce and slow stormwater runoff by intercepting precipitation and promoting infiltration

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# Battambang – case study 1: Kampong Seima Irrigation System Canal

# Battambang – case study 1: Kampong Seima Irrigation System Canal

1. Baseline assessment: description of the system, components, past extremes, response to extremes and design
2. Vulnerability assessment of system components and areas
3. Adaptation planning – options and integrated plan

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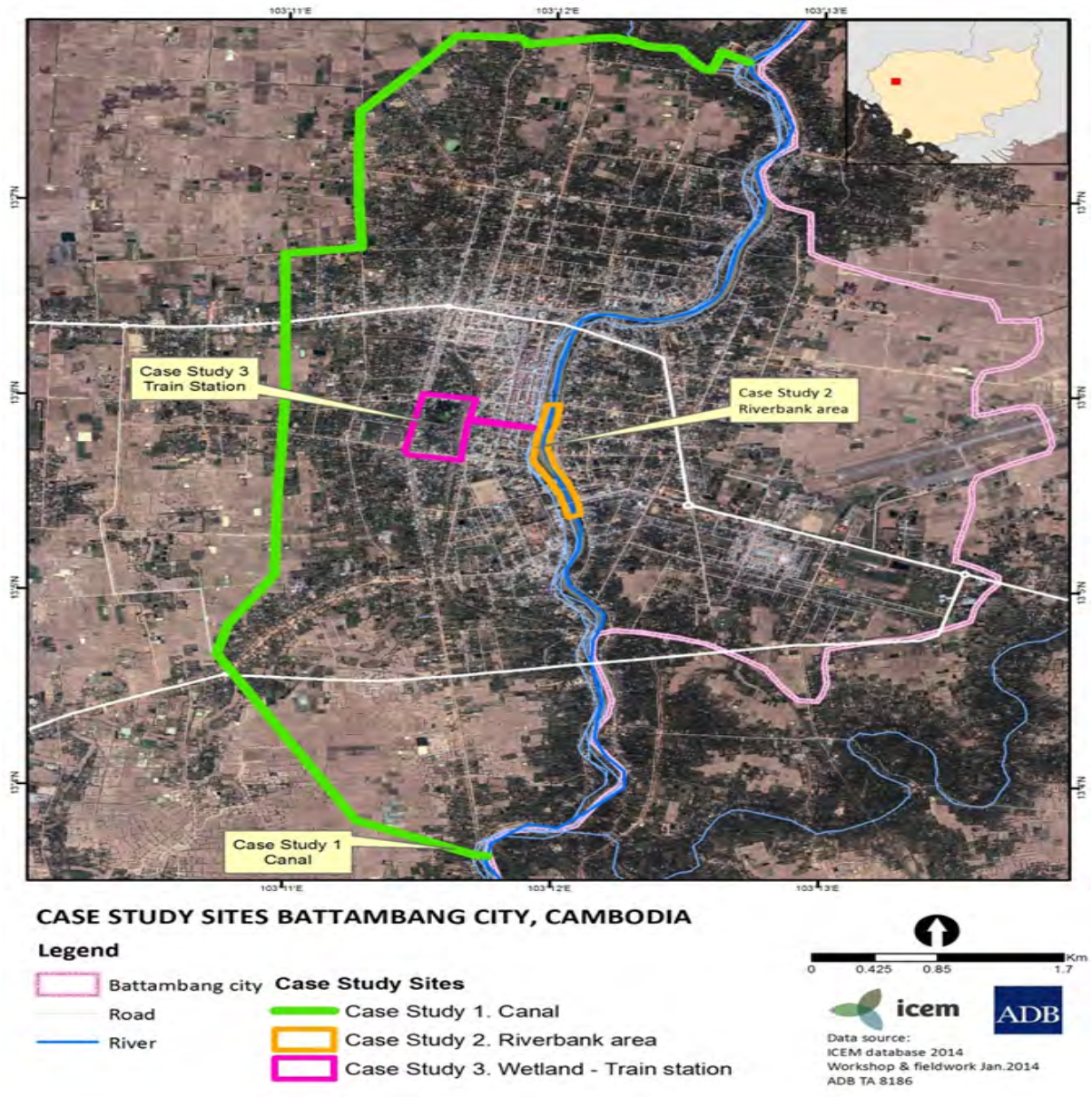
# Location of the system

- The irrigation canal was built in 1977 during the Khmer Rouge Regime
- From 1984-85: extended to 10 km length for irrigation and city flood protection.
- The canal runs 10 km through six communes
- Connects with Sangker River north and south



# Uses and service provided by the canal

- Irrigation (initial purpose)
- Fisheries
- Domestic water
- Flood protection
- Recreation
- Tourism
- Site of settlements
- Waste water and pollution sink
- Transport along dyke roads

# The whole system is vulnerable to flood from river over topping, heavy rain and increasing urban waste water

| Component | Interpretation of threat | Exposure | Sensitivity | Impact Level | Adaptive capacity | Vulnerability |
|---|---|---|---|---|---|---|
| **Canal infrastructure** | | | | | | |
| Pumping station at Kampong Seima | Floods | M | H | H | L | H |
| Culvert system at Kampong Seima | Floods | H | H | M | VL | H |
| Culvert system at National Road No.57 | Flood s | M | M | M | M | M |
| The drainage system at Deum Por, Ang village of Char Sangkat | Floods | H | H | H | L | H |
| Culvert system at National Road No.5 | Floods | L | M | M | M | L |
| **CANAL sections** | | | | | | |
| From Wat Kor (Kampong Seima) to National Road No.57 | Floods | H | H | H | L | M |
| The canal section at national road No.57 | Floods | H | H | M | VL | H |
| The Canal section at National Road No.5 | Flood s | M | H | H | L | H |
| Por Morsrey and Kdol | Floods | H | H | H | M | H |

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# Adaptation plan

- **Vision:** The canal will serve as a multi purpose green belt for the city
- Enlarge main canal and road side to 20 meter green corridor and apply bioengineering measures to bed, banks and road dyke
- Tree plantation along the canals parallel with roads
- Recreation and tourism green walkway
- Establish constructed wetlands to intercept urban waste water

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# Adaptation plan

**Institutional and Capacity Development**

- Regulate illegal resettlements  on the canal system
- Establish Farmer Water User Community (FWUC)
- Capacity building to members of CC core group
- Establish development controls and safeguards for canal corridor

# Kaysone Phomvihane – case study site 1: Southern flood gates

# Location and system components


**CASE STUDY SITE 1: SOUTHERN FLOOD GATES**
**KAYSONE PHOMVIHANE CITY, SAVANAKHET- LAO**

City boundary
Road
Case study 1: Southern Flood Gate

0 0.05 0.1 0.2 Km

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Data source:
ICEM database 2014
Workshop & Fieldwork, Nov.2013
ADB TA 8186

ADB

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# Adaptation measures for components of flood gate and canal/creek system

| System component | Adaptation measures |
|---|---|
| 1. Creek banks | Bioengineering of banks and bed |
| 2. Flood gate | Re-design for manual operation |
| 3. Agricultural fields | Flood retention and maintenance |
| 4. Fish ponds | Flood retention, bioengineering and maintenance |
| 5. Flood prone residential areas | Re-settlement, raising level of buildings, development controls |
| 6. Dike and road | Bioengineering of slopes – permeable road surface |
| 7. Watershed – town and catchment | Vegetate, manage pollution through green infrastructure approaches |

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# 1. Canal banks – bioengineering


# 1. Canal banks (stabilisation, bioegineering)


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# 2. Flood gate


Khantabouli Road
1
2
icem
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0 10 20 40
Meters
Data source:
ICEM database 2014
ADB TA 8186

# 2. Flood gate (re-design for manual operation)


3. Agricultural fields (managed as flood retention areas)

# 4. Fish ponds (managed as flood retention areas)


# 5. Flood prone residential areas


# Flooding Safeguards

| Category | Sub-category | Safeguard | Refer |
|---|---|---|---|
| Building Construction | Materials | • All building materials used below the adopted design flood level must not be susceptible to water damage. | 1 |
| | Electrical Supply | • All electrical wiring should be located above the design flood level. All electrical wiring installed below the design flood level should be suitably treated to withstand continuous submergence in water. | 2 |
| | Freeboard | • The minimum floor level of all new dwellings, or of extensions greater than 20 sqm to existing dwellings must be 300mm above the designated flood level. | 3 |
| | Storage | • Commercial and industrial development should make adequate provision of flood free storage areas for stock and equipment susceptible to water damage. | 4 |
| Earthworks | Filling | • High Hazard: Significant earthworks, including levees and raised roads, are inappropriate for floodway land.<br>• Moderate Hazard: Any fill of urban areas liable to flooding must not exacerbate flooding impact to surrounding properties. | 5 |

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# Flooding Safeguards

| Category | Sub-category | Safeguard | Refer |
|---|---|---|---|
| Site Planning | Building Orientation | • Buildings should be aligned with their longitudinal axis parallel to the direction of flood. | 6 |
| | Permeability | • Building pads should be restricted as near as practicable to the building envelope.<br>• The site area covered by pervious surfaces should be at least 20% of the site. | 7 |
| | Site coverage | • The total footprint of all buildings and structures should not exceed more than 60% of the total site area. | 8 |
| Subdivision | -- | • High hazard: Further subdivision is inappropriate unless it can be shown that the land can be filled to the design flood level without creating any adverse effect.<br>• Moderate hazard: All land, other than public roads and reserves, is to be filled to a minimum level of the design flood where an additional allotment is created. | 9 |
| Use | -- | • Development is prohibited from occurring on land subject to significant flooding. | 10 |

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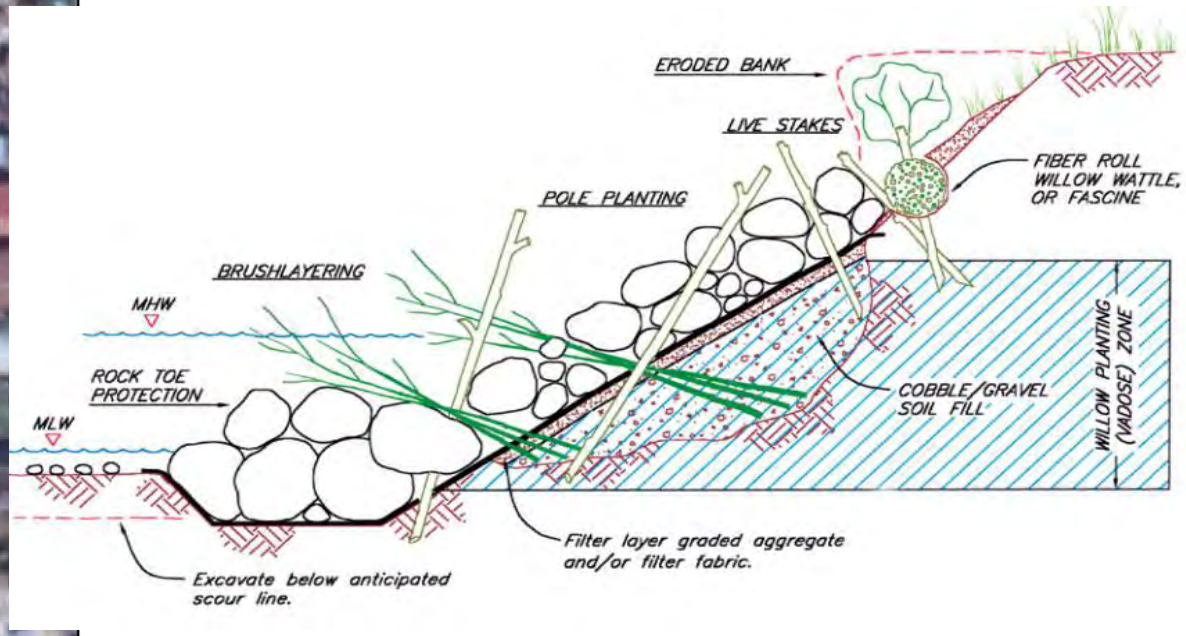
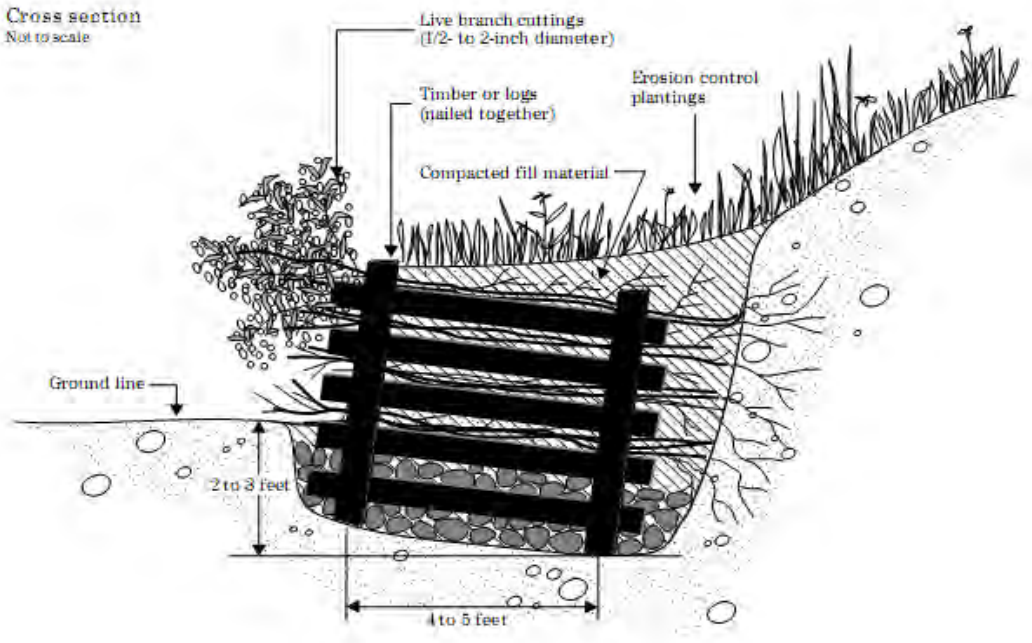
# 6. Dyke (stabilisation of slopes using bioengineering)


# Green infrastructure for slope stabilisation

- Green infrastructure **grows stronger over time**. It is **cheaper** than conventional hard infrastructure and allows for community management and involvement



# Key Outcomes:

- **Awareness** building and policy dialogues through peer learning workshops
- **Adoption** of policies and quantifiable measures for socially inclusive urban climate resilience in each participating town
- **Establishment** of climate change core groups and formalized resolutions to develop and implement climate change adaptation plans, including through green infrastructure measures.
- **Developed** learning tool as Resource Kit (7 Volumes) on Building Resilience and Sustainability in Mekong Towns – translated in local languages - based on direct inputs from field exercises on vulnerability assessments, applications of green infrastructure design solutions, and integrating these into planning processes /
- Additonally:
  - (i) **Dong Ha** People's Committee issued a decision requiring all infrastructure projects to consider bioengineering options;
  - (ii) **Kaysone Phomvihane**'s Department of Public Works adopted the core group's climate resilient design and adaptation recommendations for drainage infrastructure around the town market area which commenced construction during the project; and
  - (iii) **Battambang**'s Governor's Office issued a decision to implement the core group adaptation recommendations for rehabilitation of the Kampong Seima canal for flood and drought management.

Source : ADB. 2016, TA Completion report, Project No., 46252-001, TA 8186

The Resource Kit is at http://icem.com.au/portfolio-items/resource-kit-for-building-resilience-and-sustainability-in-mekong-towns

# Key Lessons : Replication potential

- **Programamtic approach** to adaptation within the GMS operations program.
- **Spatial Planning Reforms – Watershed approach -** in the development control processes to respond effectively to climate change.
  - Emphasize rehabilitating and expanding natural systems in towns are essential for building urban resilience.
- **Master plan preparation and review process reforms** to include criteria for local area adaptation planning, design and inclusion of non-structural measures or **Green infrastructure.**
- **Formation of core groups** are well positioned to deepen capacity building within their relevant line agencies. Effective demonstration of train the trainers and participatory approach to facilitate **cross-sector collaboration.**
- **Demonstration sites can be created** on adaptation across the GMS for scaling up effective solutions.

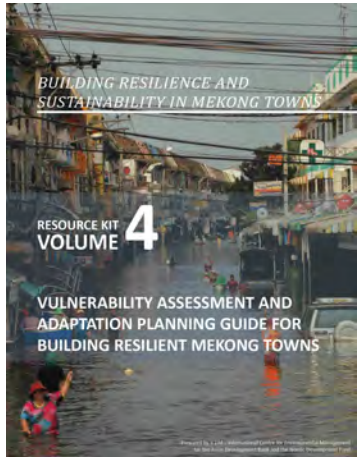
Source : ADB. 2016, TA Completion report, Project No., 46252-001, TA 8186

# Learning Tools

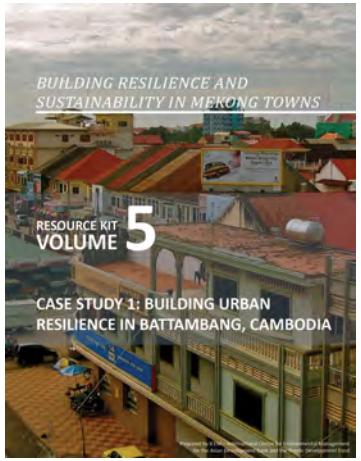
## Resource Kit for Building Resilience and Sustainability in Mekong Towns

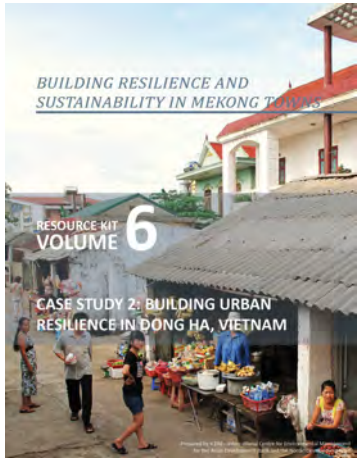
## Nature Based Solutions for Building Resilience in Towns and Cities









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