Virtual Dialogues on

RESILIENT INFRASTRUCTURE

Nature-based Solutions for Resilient Infrastructure

14 July 2021

Sponge Cities in the People's Republic of China - Evolution of ADB Support

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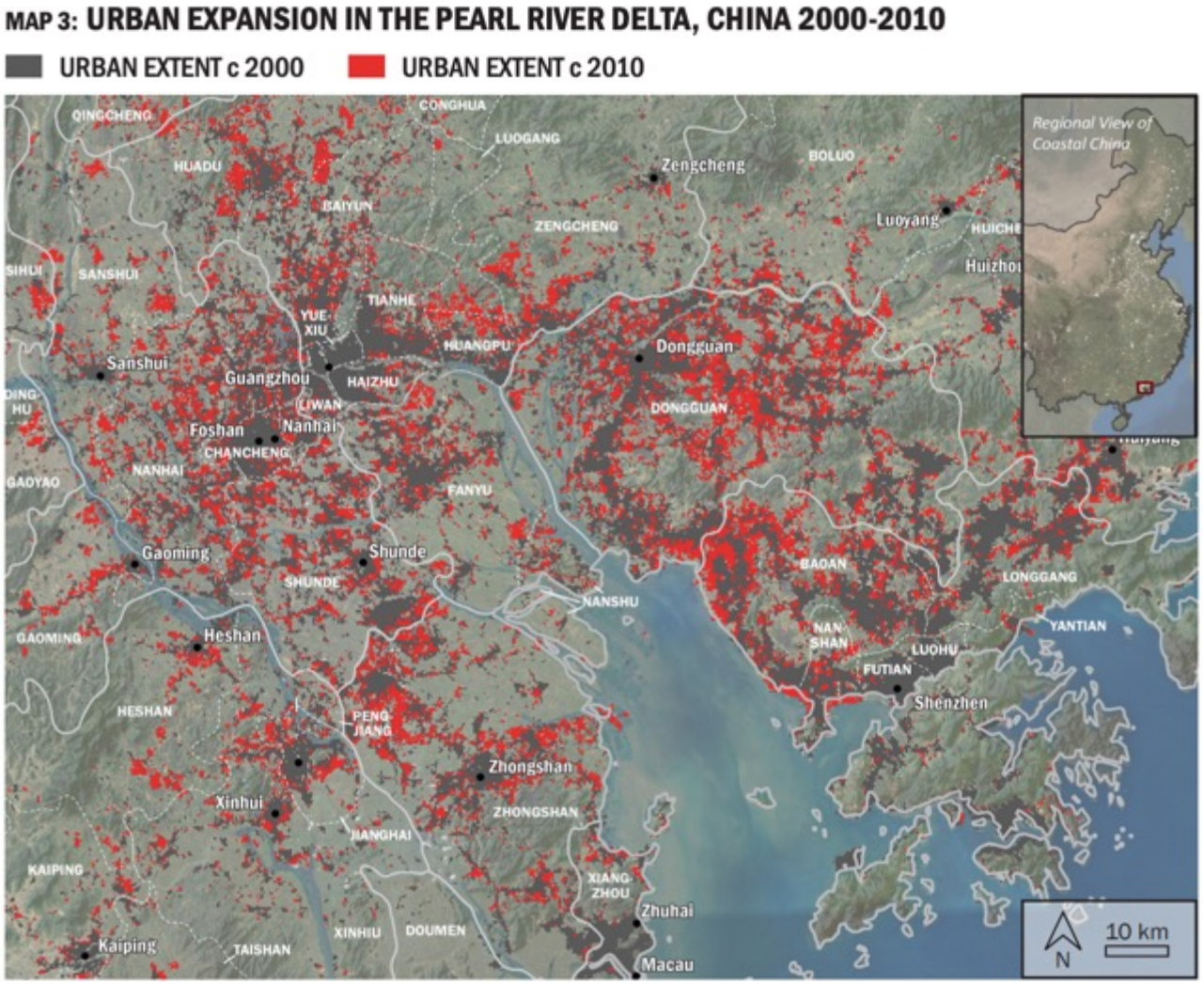
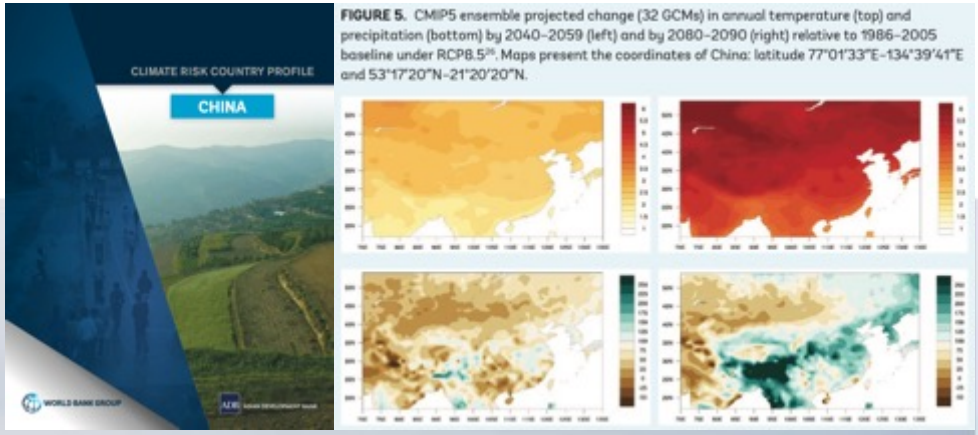
Challenges: Urbanization + Climate Change = Disaster, Health, Environment, Water



China's Pearl River Delta urban area has surpassed Tokyo.
Source: Maps produced by University of Wisconsin-Madison, Sept. 2013; Administrative boundaries from University of

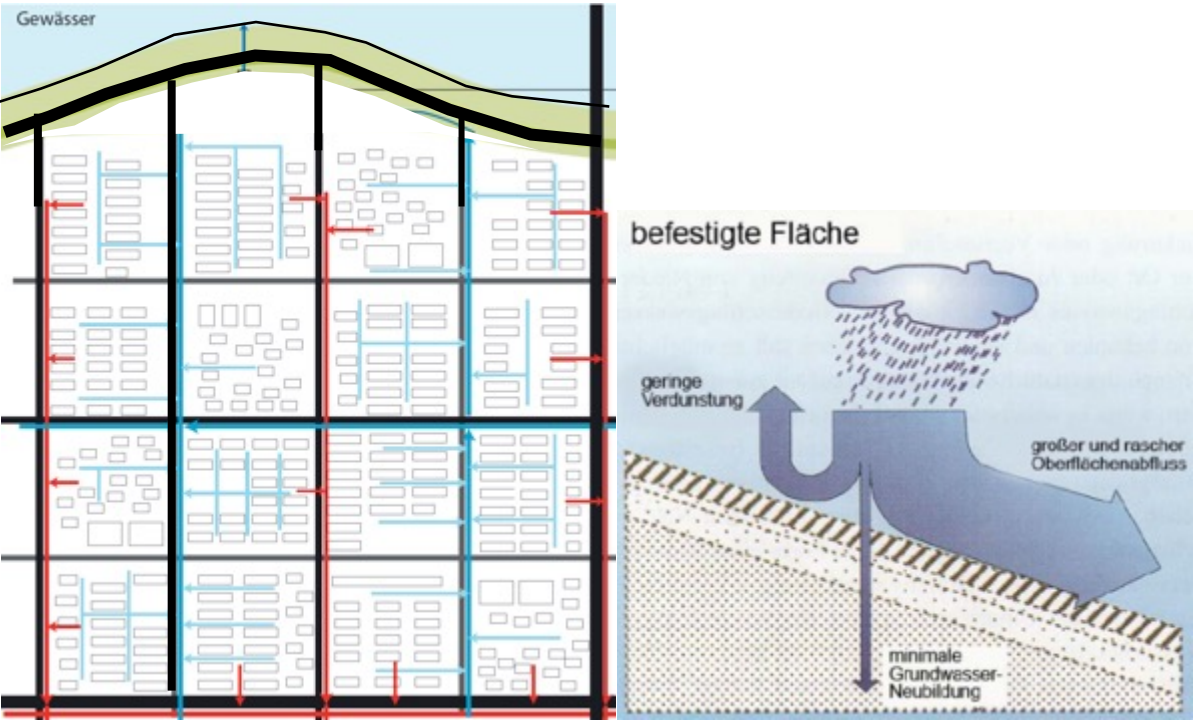


Sponge Cities: Manage Pluvial and Fluvial Flooding, Reuse Rainwater

1. Sponge City technical guidelines and government program supporting 30 pilot cities in two phases since 2015.
2. Sponge city borrows concepts from prior science and practices around the world, e.g., low-impact design, water-sensitive design, ecosystem-based adaptation, sustainable rainwater management, and others.
3. Responds to increasing climate-change-related flooding and long dry periods.
4. Follows principles of sustainable urban rainwater and flood risk management by reducing paved areas, making cities more pervious like a sponge, and increasing the capture and reuse of rainwater, among other measures.
5. Improves management of urban water cycle through decentralized management of rain-/ stormwater.
6. Contributes to improved overall urban water resource management by addressing flooding, water scarcity, and pollution.
7. Contributes to managing pluvial flooding (urban waterlogging) caused by increased runoff from paved areas in expanding and less green cities, and fluvial flooding (river flooding) aggravated by reduced space and channelization of rivers.
8. Pluvial urban flooding management is to retain stormwater in a cascading system of green infrastructure (like green roofs, rain gardens, parks, bioswales) to store and slow down the outflow into the drainage pipes and canals, and to treat water in sedimentation wetland ponds and sand filters before the water is discharged into rivers.
9. Fluvial flooding management uses proteced green space and wetlands and rehabilitate floodplains and riparian landscapes to retain water and increase the flow capacity of rivers.
10. Future concepts should consider more weather extremes, and precipitation, including that of extreme storm events, may need to be considered as water resource to manage the longer dry periods also caused by climate change.

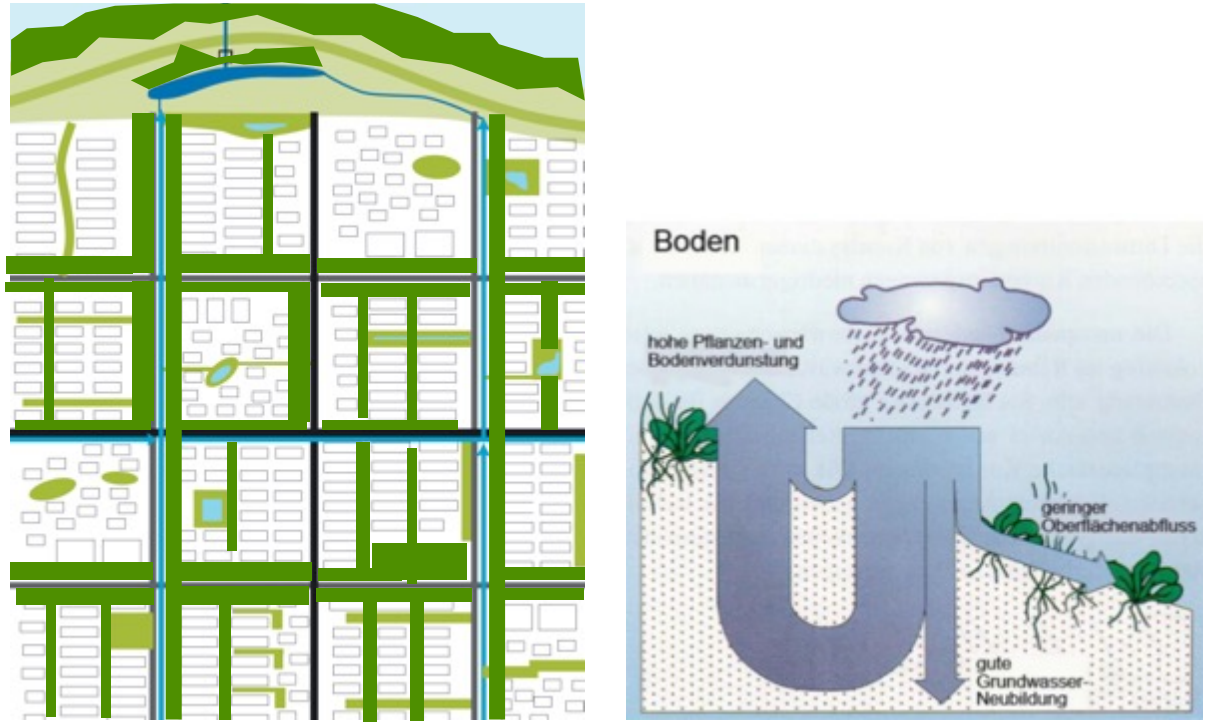
More Urban Runoff from Buildings and Paved Surfaces

Typical urban runoff and drainage system



Adapted from Wasser Hannnover GmbH

Sponge city: NBS green + gray system



Adapted from Wasser Hannnover GmbH

Sponge Measures: Green Infrastructure, Nature-based Solutions: Pluvial + Fluvial

Protect open green space, parks, green roofs, rain gardens, bio-swales, parking, wetlands and river greenways

For reference:
United States Environmental Protection Agency (EPA):

”Green infrastructure uses plants, soils, and nature itself to manage stormwater and create healthier urban environments. Green infrastructure practices can be used to reduce the need for expensive gray infrastructure—pipes, storage facilities, and treatment systems—because plants and soils soak up, store, and use the rainwater. Communities also can create or preserve existing vegetated areas to maintain a high quality of life for residents through flood protection, cleaner air and water, and more appealing transportation corridors and outdoor spaces.”

Downspout Disconnection

Rerouting rooftop drain pipes to direct rainwater to rain barrels, cisterns, or permeable areas instead of the sewer. This practice can benefit any community but can be particularly beneficial in cities with combined sewer systems.

Rain Gardens and Bioswales

Shallow, vegetated areas that collect and absorb runoff from rooftops, sidewalks, and streets using plants and soil. Versatile, attractive features that can be installed in almost any unpaved space. Also known as bioretention or bioinfiltration cells.

Green Roofs

Roofs covered with plants that soak up and use rainwater. They cool and insulate buildings, reducing energy use. They are particularly cost effective where land values and traditional stormwater management costs are high.

Green Alleys and Streets

Permeable pavement, bioswales, planter boxes, and trees integrated into street and alley designs to soak up and store stormwater and improve the pedestrian experience through shading and traffic calming.

Land Conservation

Protecting open spaces and sensitive natural areas within and adjacent to a city can reduce stormwater while providing recreational opportunities for city residents. Natural areas that should be a focus of this effort include riparian areas, wetlands, and steep hillsides.

Rainwater Harvesting

Systems that collect and store rainfall for later use, slowing and reducing the volume of runoff. This can be especially important in arid regions to reduce demands on increasingly limited water supplies.

Planter Boxes

Rain gardens that collect and absorb runoff from rooftops, sidewalks, parking lots, and streets. They have vertical walls that are ideal for space-limited sites in dense urban areas and can be used to provide seating and attractive plantings.

Permeable Pavements

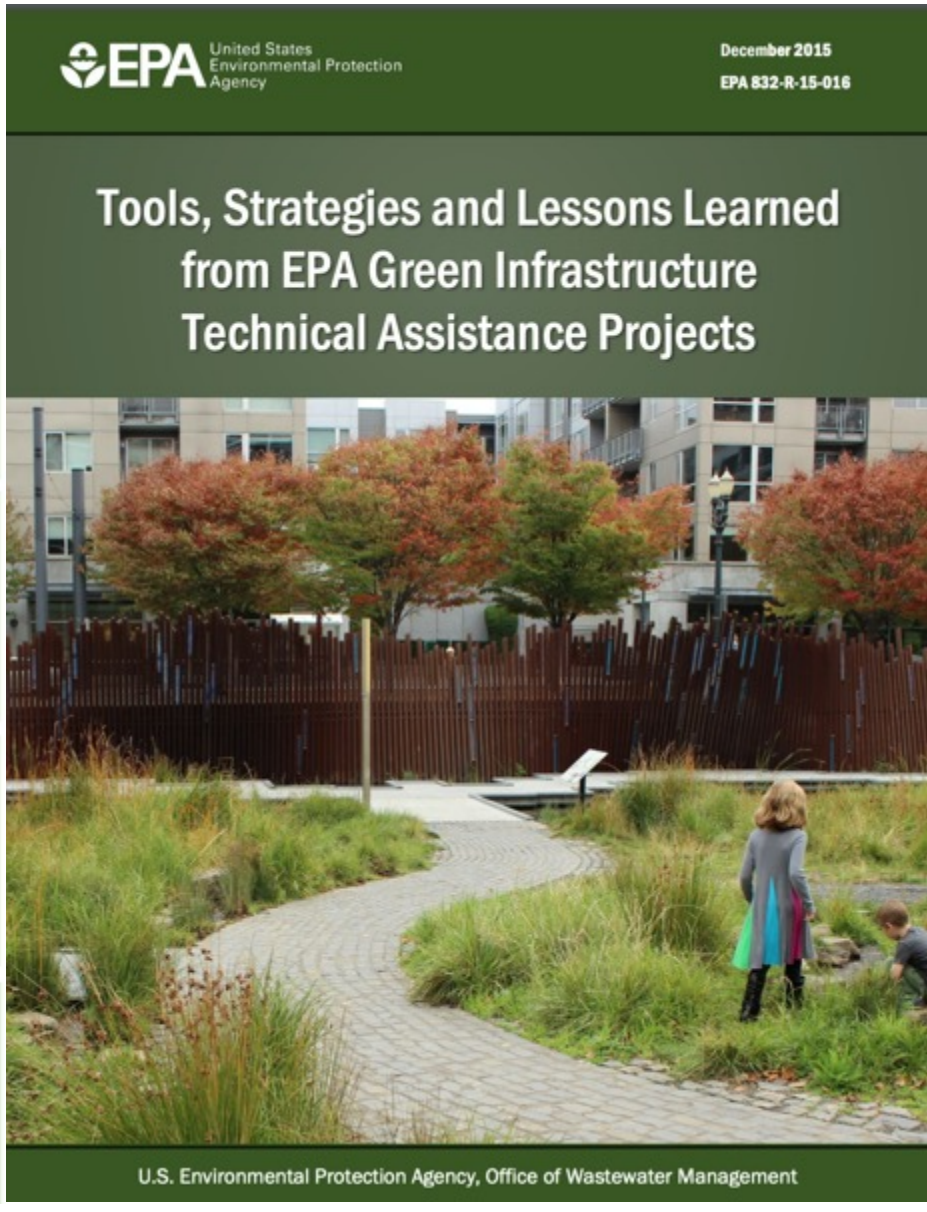
Paved surfaces that let water soak into the ground, including pervious concrete, porous asphalt, and permeable interlocking pavers. They are particularly cost effective where land values are high and where flooding or icing is a problem.

Green Parking

Permeable pavement, rain gardens, and bioswales incorporated into parking lot stalls, lanes, and landscaping. Besides collecting and absorbing stormwater, green parking can provide more shade and reduce the heat emitted by pavements.

Urban Tree Canopy

Urban trees soak up and use rainwater, provide shade and help to slow traffic. Homeowners, businesses, and cities can all participate in the planting and maintenance of trees throughout the urban environment.



Sponge City: Part of Integrated Disaster Risk Management

Chart of the Sendai Framework for Disaster Risk Reduction
2015-2030

Scope and purpose

The present framework will apply to the risk of small-scale and large-scale, frequent and infrequent, sudden and slow-onset disasters, caused by natural or manmade hazards as well as related environmental, technological and biological hazards and risks. It aims to guide the multi-hazard management of disaster risk in development at all levels as well as within and across all sectors

Expected outcome

The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries

Goal

Prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience

Targets

Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality between 2020-2030 compared to 2005-2015	Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 between 2020-2030 compared to 2005-2015	Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030	Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030	Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020	Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030	Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030

Priorities for Action

There is a need for focused action within and across sectors by States at local, national, regional and global levels in the following four priority areas.

Priority 1	Priority 2	Priority 3	Priority 4
Understanding disaster risk	Strengthening disaster risk governance to manage disaster risk	Investing in disaster risk reduction for resilience	Enhancing disaster preparedness for effective response, and to «Build Back Better» in recovery, rehabilitation and reconstruction
Disaster risk management needs to be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment	Disaster risk governance at the national, regional and global levels is vital to the management of disaster risk reduction in all sectors and ensuring the coherence of national and local frameworks of laws, regulations and public policies that, by defining roles and responsibilities, guide, encourage and incentivize the public and private sectors to take action and address disaster risk	Public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment. These can be drivers of innovation, growth and job creation. Such measures are cost-effective and instrumental to save lives, prevent and reduce losses and ensure effective recovery and rehabilitation	Experience indicates that disaster preparedness needs to be strengthened for more effective response and ensure capacities are in place for effective recovery. Disasters have also demonstrated that the recovery, rehabilitation and reconstruction phase, which needs to be prepared ahead of the disaster, is an opportunity to «Build Back Better» through integrating disaster risk reduction measures. Women and persons with disabilities should publicly lead and promote gender-equitable and universally accessible approaches during the response and reconstruction phases

Guiding Principles

Primary responsibility of States to prevent and reduce disaster risk, including through cooperation	Shared responsibility between central Government and national authorities, sectors and stakeholders as appropriate to national circumstances	Protection of persons and their assets while promoting and protecting all human rights including the right to development	Engagement from all of society	Full engagement of all State institutions of an executive and legislative nature at national and local levels	Empowerment of local authorities and communities through resources, incentives and decision-making responsibilities as appropriate	Decision-making to be inclusive and risk-informed while using a multi-hazard approach

Coherance of disaster risk reduction and sustainable development policies, plans, practices and mechanisms, across different sectors	Accounting of local and specific characteristics of disaster risks when determining measures to reduce risk	Addressing underlying risk factors cost-effectively through investment versus relying primarily on post-disaster response and recovery	«Build Back Better» for preventing the creation of, and reducing existing, disaster risk	The quality of global partnership and international cooperation to be effective, meaningful and strong	Support from developed countries and partners to developing countries to be tailored according to needs and priorities as identified by them

www.preventionweb.net/go/sfdrr
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UNISDR

STRUCTURAL MEASURES

Reduce runoff

Improve runoff retention

Optimize drainage systems

Enhance river capacity

Create diversion channels

NON-STRUCTURAL MEASURES

Flood risk mapping & zoning

Flood forecasting & early warning systems

Land use planning

Flood proofing

Enforcing codes for building & municipal drainage

Disseminate flood risk information

Develop & test emergency management plans

Insurance

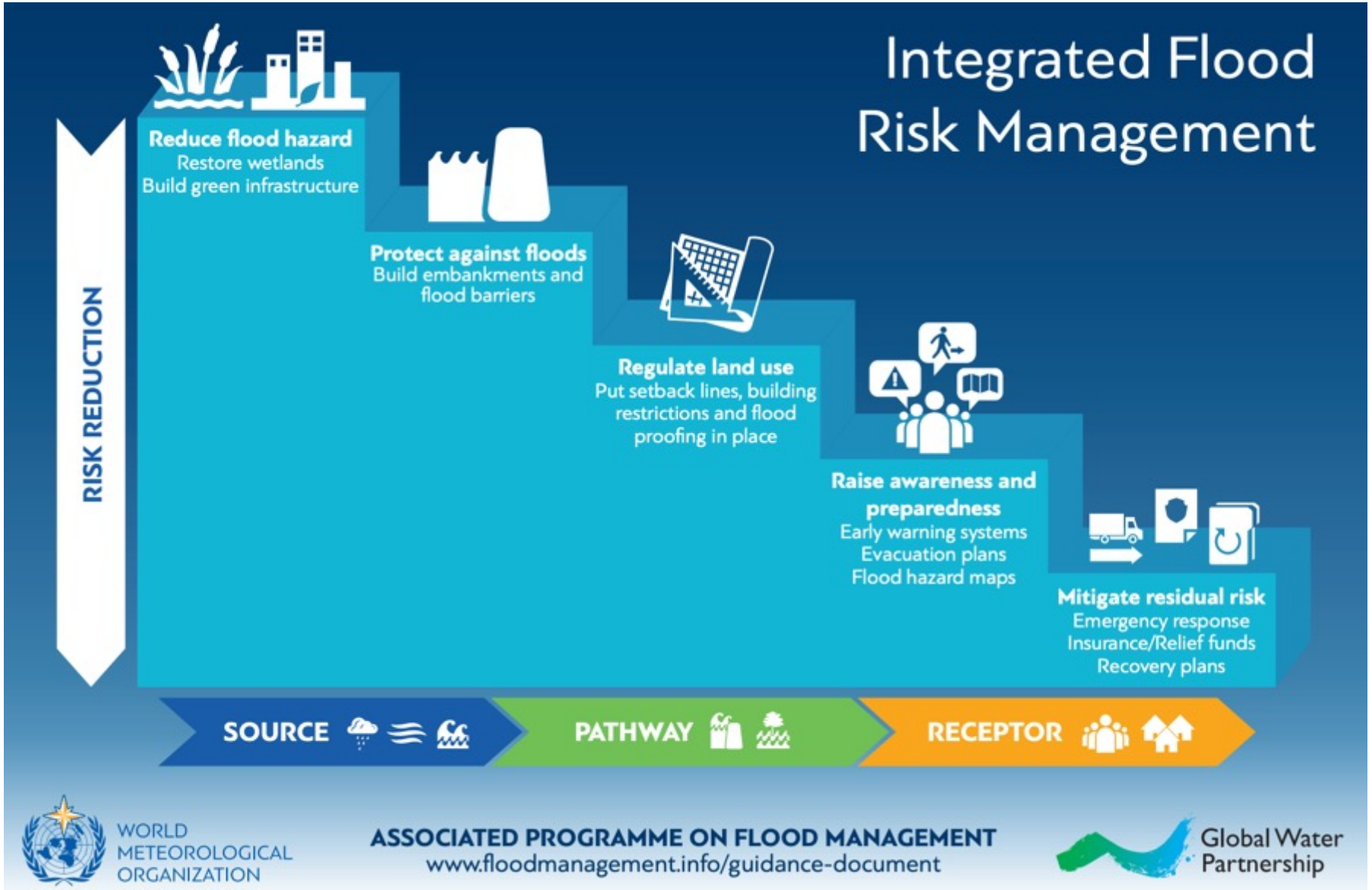
Train emergency teams

WORLD METEOROLOGICAL ORGANIZATION

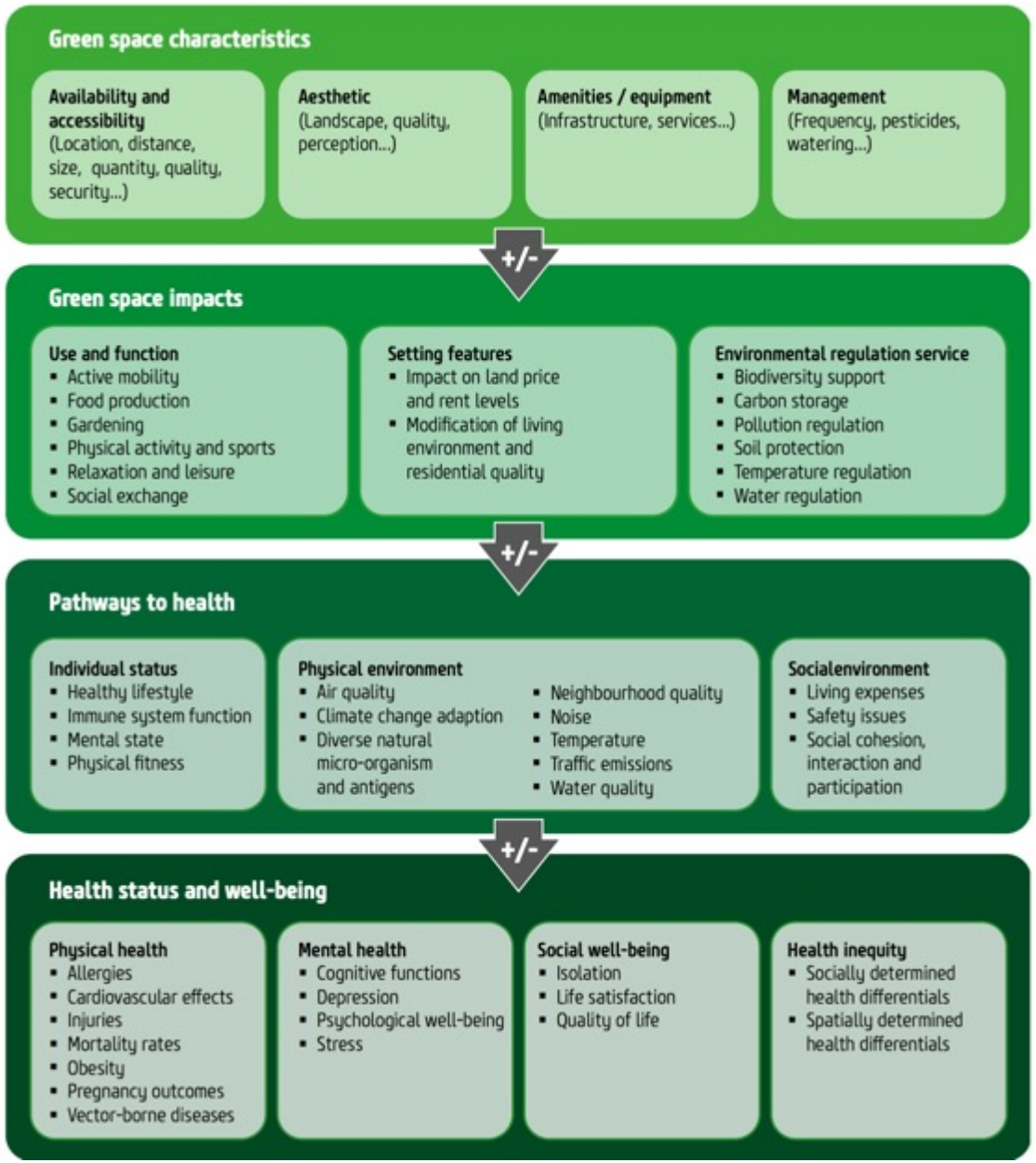
ASSOCIATED PROGRAMME ON FLOOD MANAGEMENT

Global Water Partnership

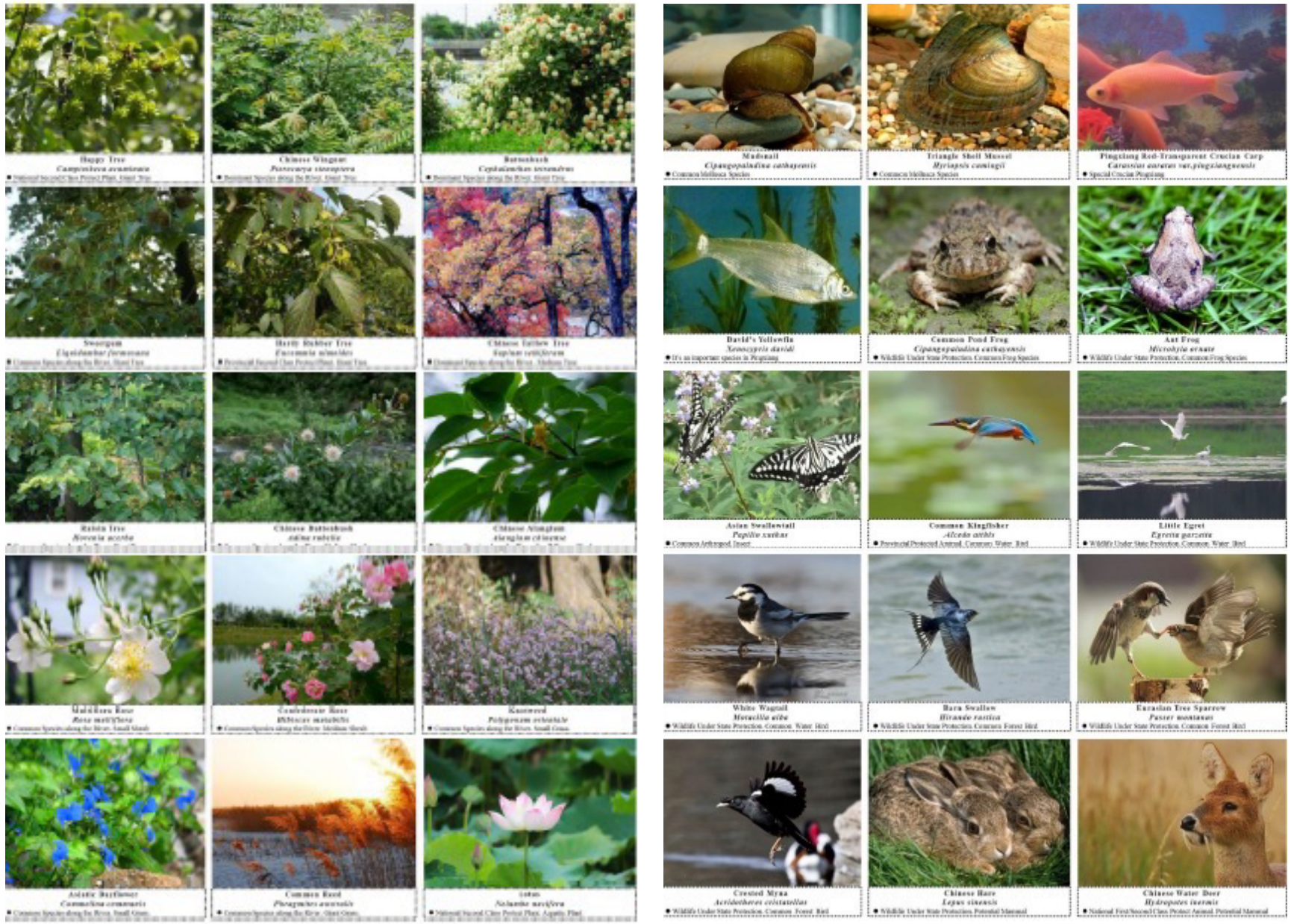
Sponge City: Part of Integrated Flood Risk Management



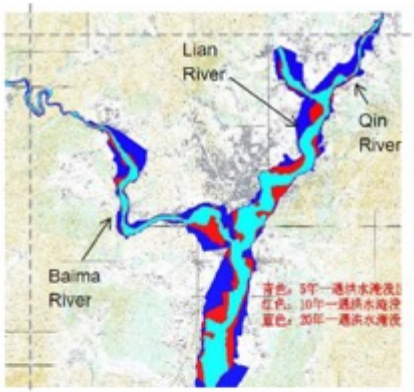
Sponge City: Human Health Pathways of Urban Green Spaces

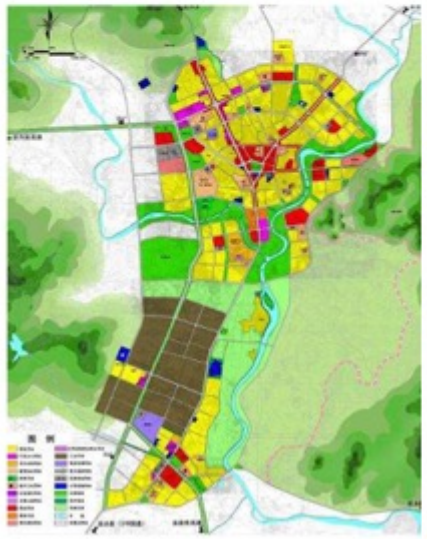


Sponge City: Improving Environment, Ecology, Biodiversity and Water Quality



1. Jiangxi Pingxiang Integrated Rural-Urban Infrastructure Development Project

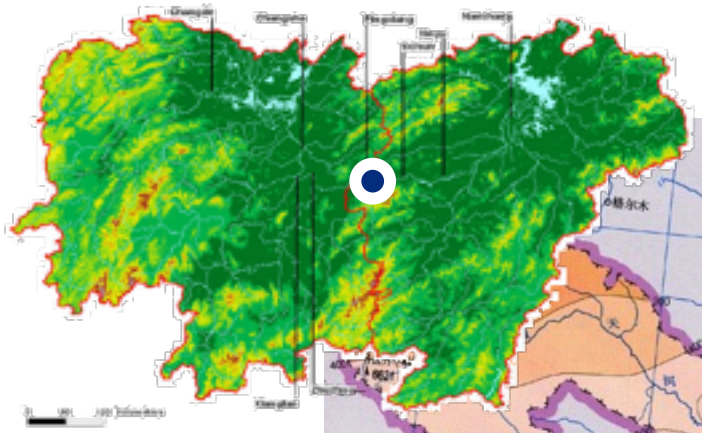


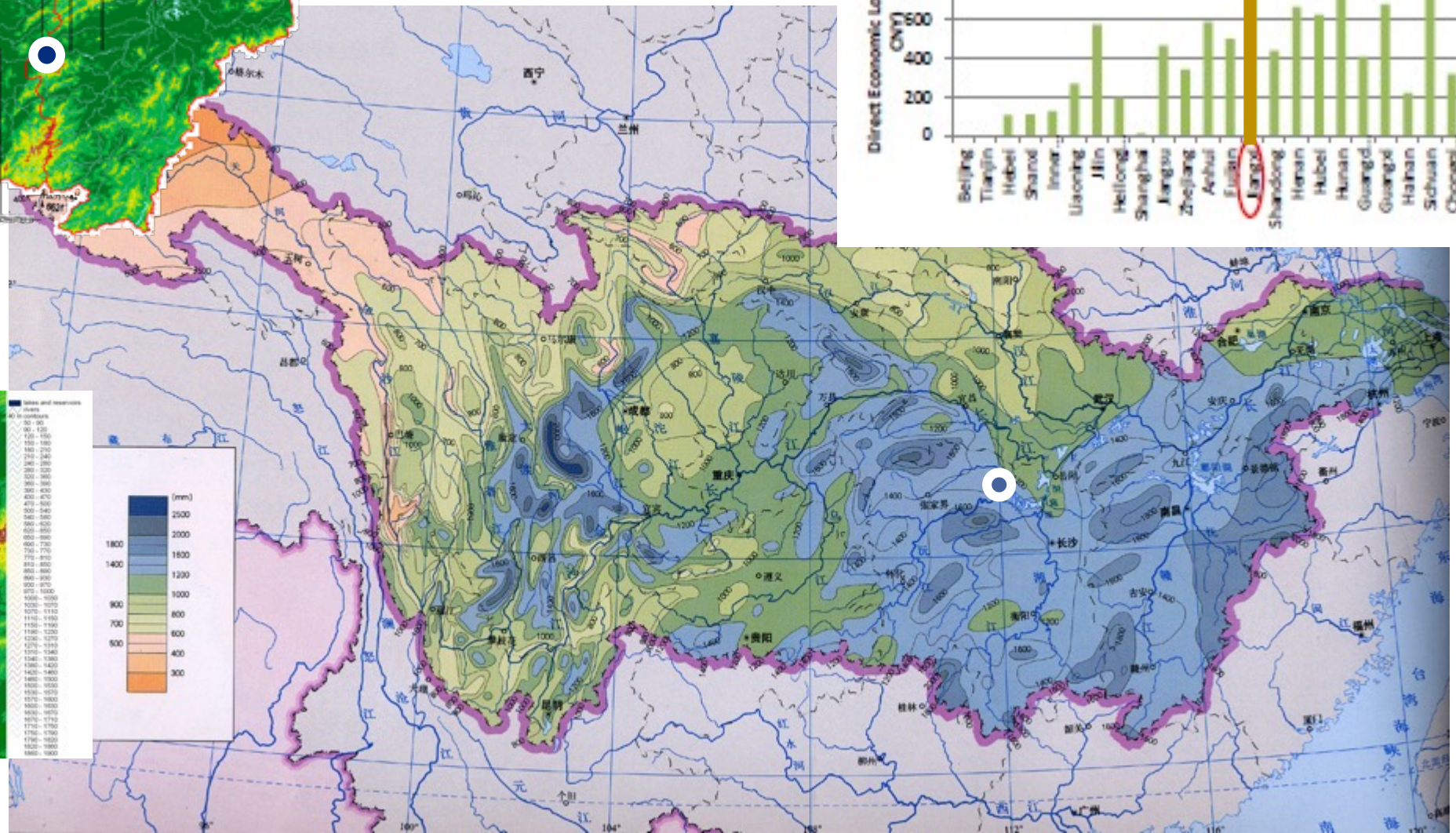


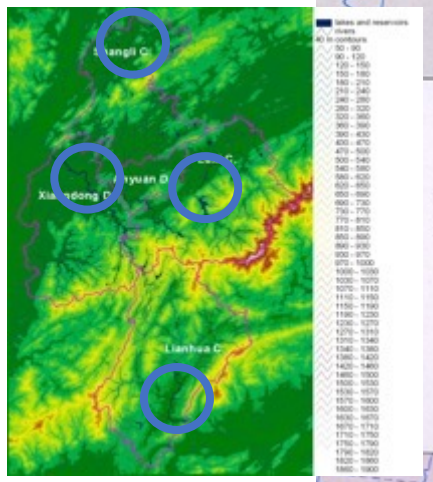
The overall objective of sponge cities is to improve the management of the urban water cycle especially through decentralized management of rainwater and stormwater. It also contributes to improved overall water resource management of a city by addressing flooding, water scarcity and pollution. The sponge city concept takes into consideration increased climate variability which leads to extreme flooding and longer dry periods and extreme heat over the year. Stormwater, which may otherwise flood and affect people and urban areas and their assets, is slowed down, and detained to remove its potentially destructive force. Rainwater is filtered and released slowly using green systems, just like a sponge does, and/or stored and reused after storms when less water is available, for landscape irrigation, street cleaning, or other urban uses. ADB projects focus on nature-based solutions. Sponge cities ideally integrate green and gray infrastructure systems to optimize benefits.

1. Jiangxi Pingxiang Integrated Rural-Urban Infrastructure Development Project

Jiangxi is Third Most Affected Province in PRC Between 2000 to 2010







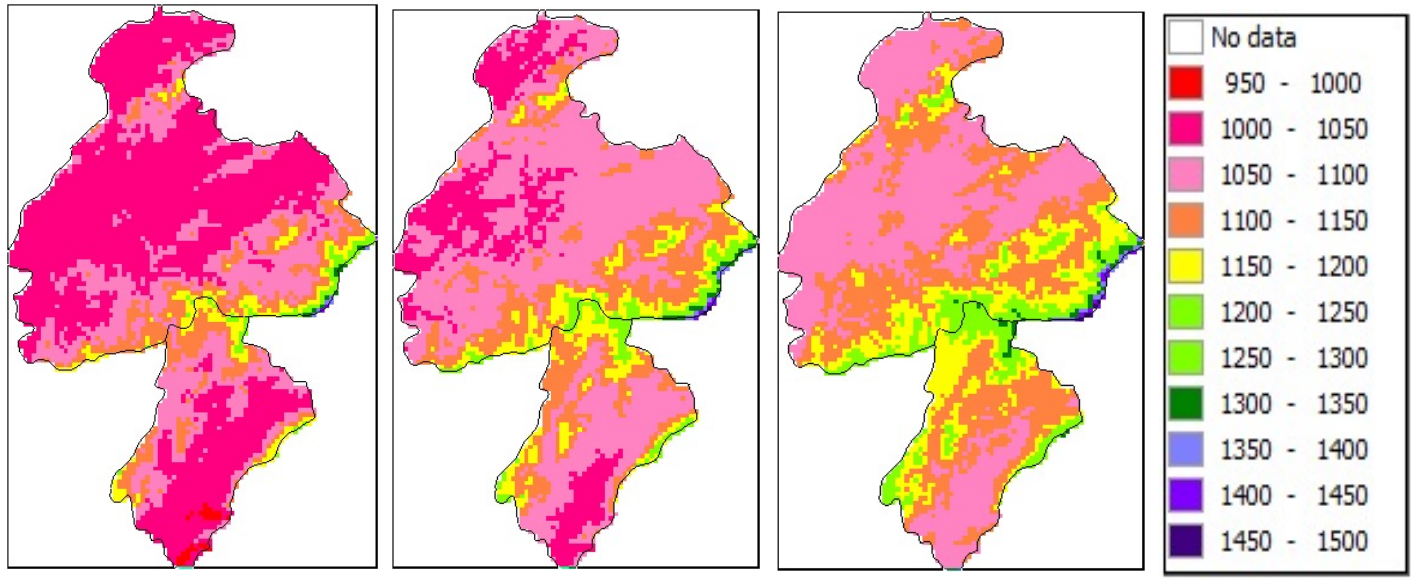
1. Jiangxi Pingxiang Integrated Rural-Urban Infrastructure Development Project

Increasing Frequency and Severity of Flooding In Pingxiang

1. Jiangxi Pingxiang Integrated Rural-Urban Infrastructure Development Project

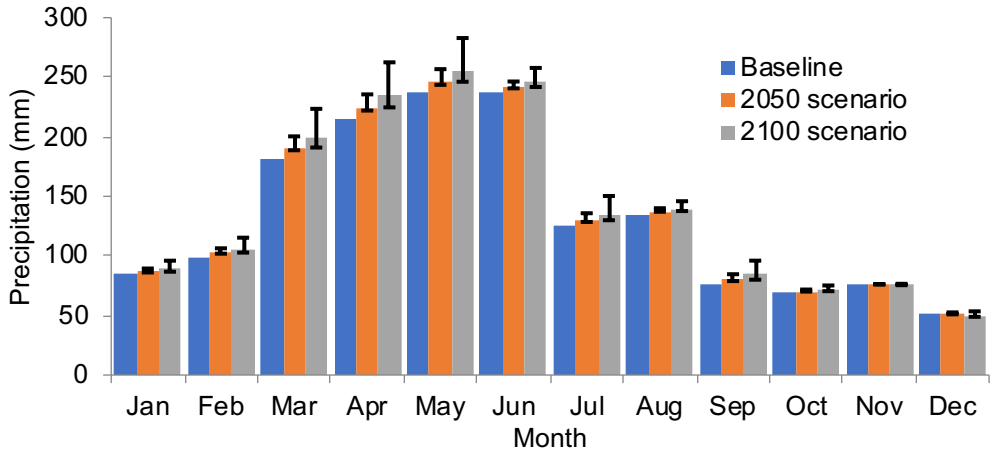
ADB'S CLIMATE RISK AND VULNERABILITY ASSESSMENT

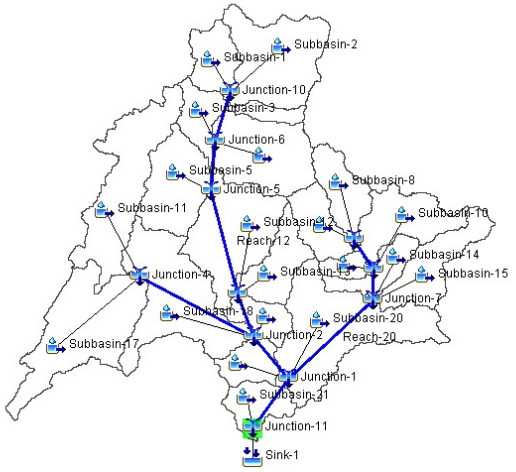
Flood season (Apr-Oct) rainfall distribution (mm): baseline and 2050, 2100 median scenario



Baseline **2050 Median scenario** **2100 Median scenario**

ADB CRVA PRECIPITATION RELATED CLIMATE VARIABLES AND FUTURE PROJECTIONS, HYDRAULIC MODELLING AND CALIBRATION USING RIVER GAUGES AND PAST EVENTS

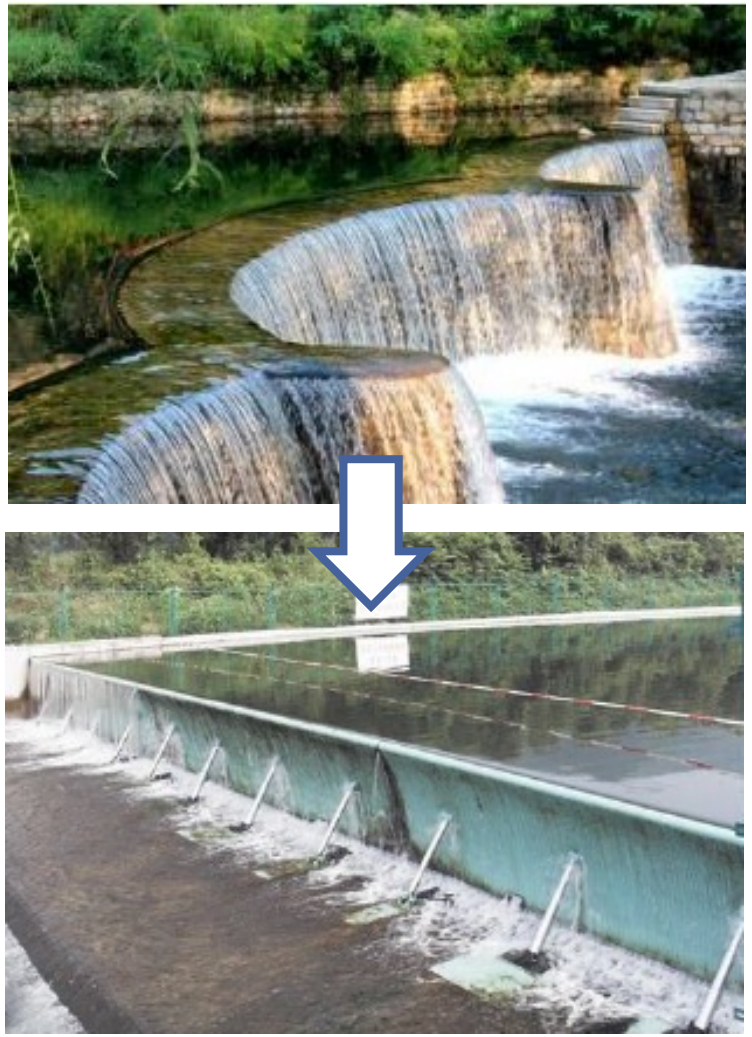




1. Jiangxi Pingxiang Integrated Rural-Urban Infrastructure Development Project

ADB CRVA RECOMMENDATIONS FOR ADAPTATION MEASURES SUMMARY

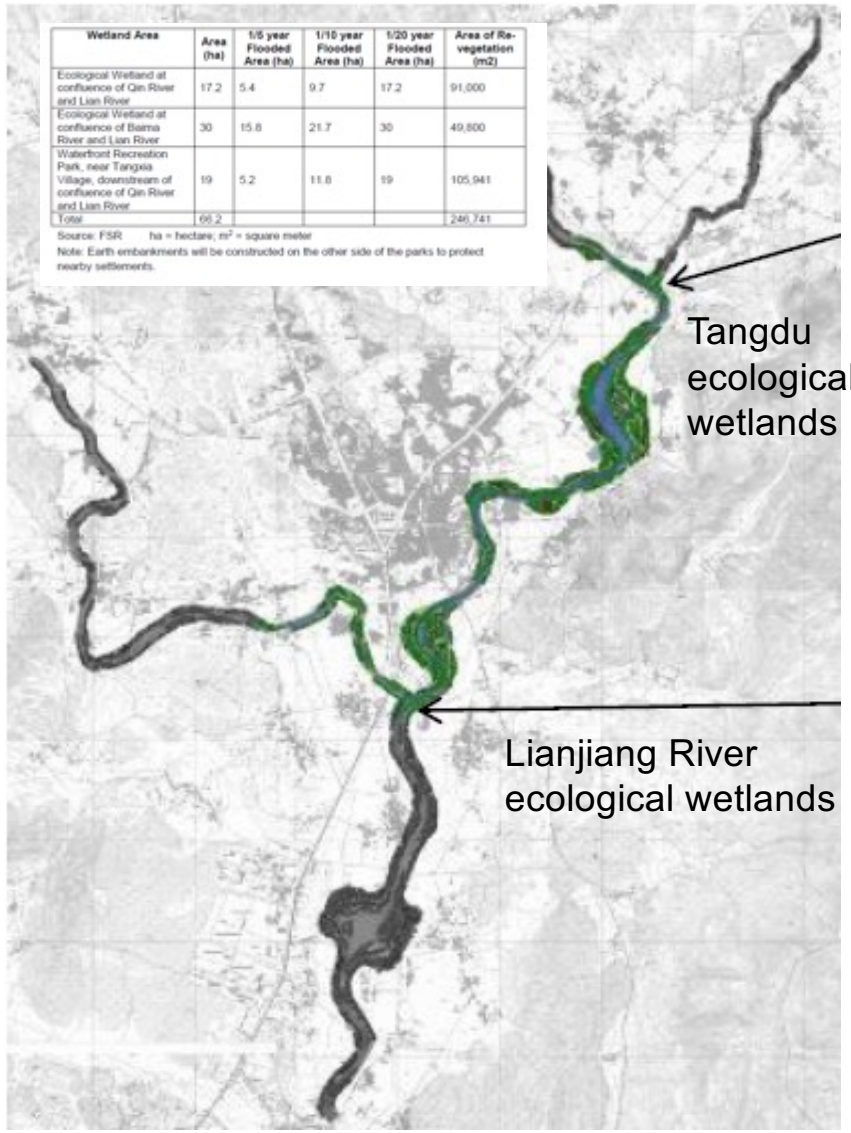
Adaptation measure	priority	Implementation schedule
Adjustment of 6% increase in design storm; adjustment of 0.2 m increase in design flood	Moderate	Project's detailed design phase
Adjustment of 20% increase in design storm; adjustment of 0.4 m increase in design flood	Moderate	Project's detailed design phase
Enlarge storm water outlet size according to 10% increase of design storm	High	Project's detailed design phase
Remove or change structure of dams blocking flood water	High	Detailed design phase
Complete a functional solid waste collection system	Moderate	Project implementation (Capacity Building)
Ecological restoration of the project area	High	Detailed design stage, long term
Strengthen existing flood monitoring and warning systems	Moderate	Project implementation (Capacity Building)
Institutional capacity building for CC impact adaptation planning	Moderate	Project implementation (Capacity Building)



1. Jiangxi Pingxiang Integrated Rural-Urban Infrastructure Development Project

PRIORITY ENVIRONMENTAL PROTECTION AND REHABILITATION PROJECTS

LIANHUA AND LUXI RIPARIAN REVEGETATION AND WETLAND PROTECTION



Wetland Area	Area (ha)	1/5 year Flooded Area (ha)	1/10 year Flooded Area (ha)	1/20 year Flooded Area (ha)	Area of Re-vegetation (m2)
Ecological Wetland at confluence of Qin River and Lian River	17.2	5.4	9.7	17.2	91,000
Ecological Wetland at confluence of Baima River and Lian River	30	15.8	21.7	30	49,800
Waterfront Recreation Park, near Tangxia Village, downstream of confluence of Qin River and Lian River	19	5.2	11.8	19	105,941
Total	66.2				246,741

Source: FSR ha = hectare; m^2 = square meter

Note: Earth embankments will be constructed on the other side of the parks to protect nearby settlements.

Zone	Area (ha)	Key Functions	Planned Works[1]
Forest Water Gap Park Zone	5	Restore and protect the forests and build up natural landscaping	Forest restoration along the river Landscaping Parks along Yuan River Water front platform and walkways
Ecological Park Zone	20	Preserve the wild riparian condition and restore selected vegetation for a high quality of aesthetics.	Restore river riparian Plant Chinese traditional flowers Various view points as leisure area
Urban Riparian Ecological Zone	14	Combine with urban flood control and urban greenscape to provide an area for leisure and recreation	Recreation areas for local residents Landscaping and vegetation along the residential area
Yuan River Riparian Restoration and Rehabilitation Zone	4	Restore riparian areas while conducting scientific research and monitoring, and convert area to a protection and conservation zone	Restore riparian system Release fish Small islands restoration at the confluent of the Yuan, Xinhua and Tankou River Plant wetland plants

1. Includes overall plans for the park. The portion to be supported by the ADB loan can be various.

Source: FSR ha = hectare

1. Jiangxi Pingxiang Integrated Rural-Urban Infrastructure Development Project

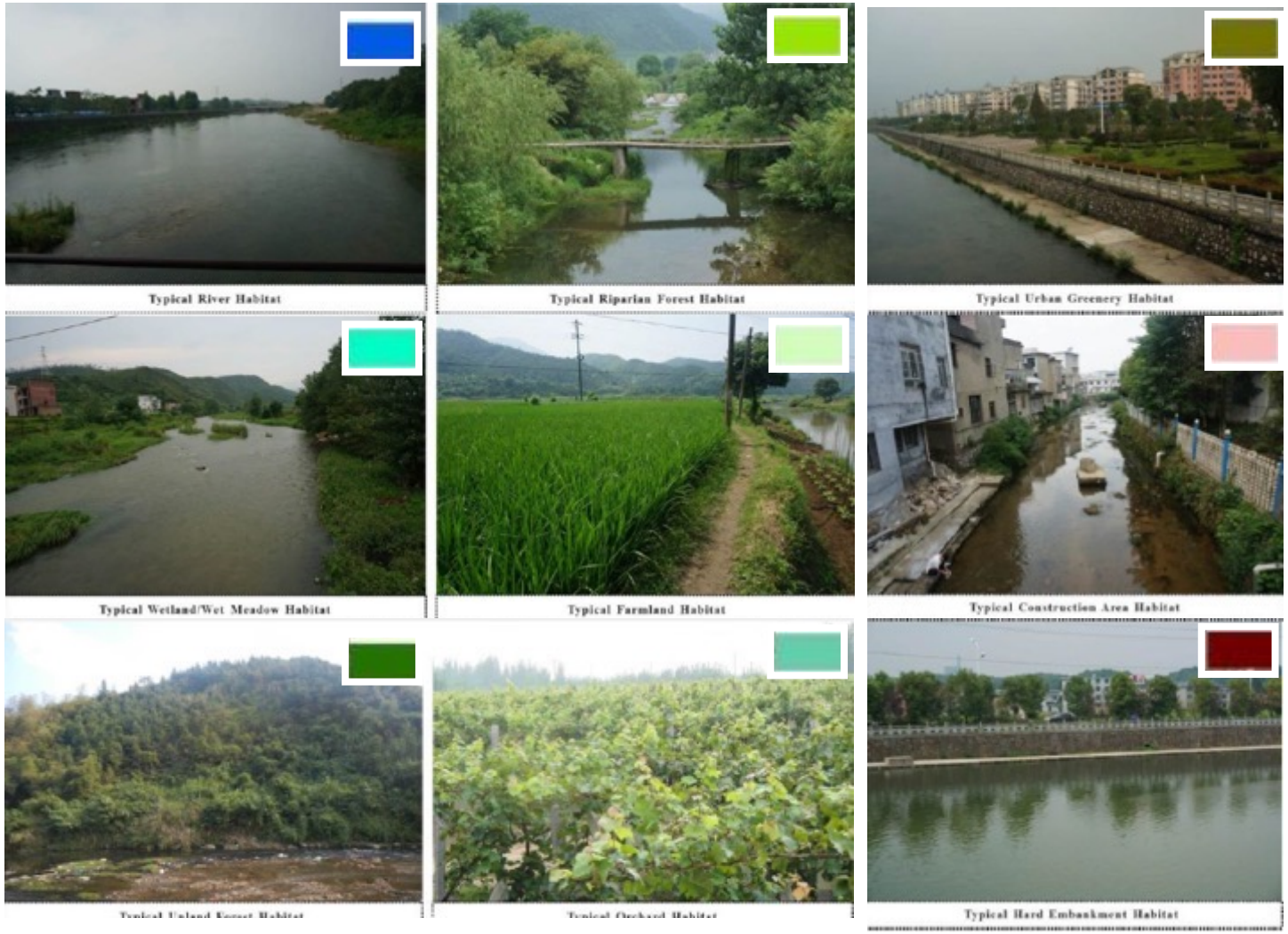
DESIGN OF KEY NODES LIANHUA

- Preserve new retaining wall on the southwest side, and raise the existing road to meet flood protection standards;
- Preserve large trees along the road on the southwest side, and plant more trees along the shoreline to improve connectivity of the riparian tree belt;
- Plant shoreline aquatic plants along the existing pebble beach on the southwest side to form riparian wetlands;
- Preseve existing forested areas on the northwest and north east sections, build up natural slopes to meet flood protection requirements;
- Preserve high quality wetland habitat at the confluence of the two rivers, and use wetland islands to improve landscaping and provide opportunities for leisure activities.

1. Jiangxi Pingxiang Integrated Rural-Urban Infrastructure Development Project

GREEN Wherever Possible and GRAY if no Space in Existing Cities

Habitat type
River
Riparian Forest
Wetland/ Meadow
Farmland
Upland Forest
Orchard
Urban Greenery
Fish Pond
Constructed Area
Hard Embankment

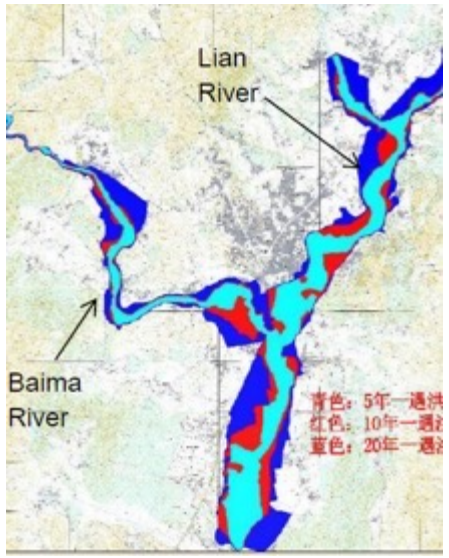


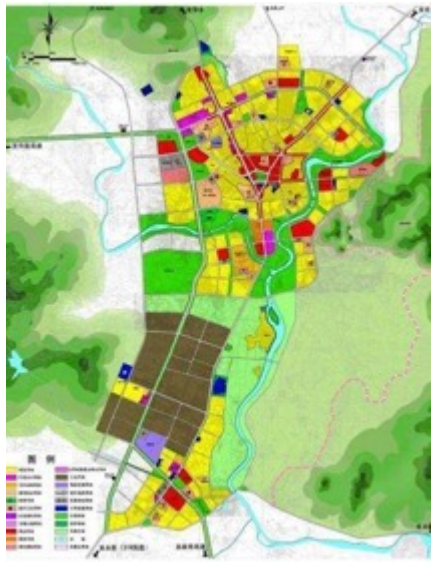
GREEN AND GRAY RIVER ENVIRONMENTS IN PRC JIANGXI PINGXIANG

1. Jiangxi Pingxiang Integrated Rural-Urban Infrastructure Development Project

Project Addresses Key Development Challenges

1. Promote **balanced rural-urban development and integration, reduce rural-urban income** and services **gap**, and **out-migration push factors**;
2. Improve **safety from flooding** for 308,000 residents and **enhance river environment**, restore riparian ecology and wetlands, preserve floodplains;
3. Reduce water, soil, and groundwater pollution by increasing **wastewater collection and treatment benefitting** 175,000 residents, improve water safety;
4. Improve **road connectivity for** 247,000 farmers and residents of **rural townships and villages** to access urban markets, jobs and services; and
5. Structural interventions are complemented by **non-structural initiatives to increase project sustainability** and enhance local development capacity.





1. Jiangxi Pingxiang: Well-planned Green Spaces Create Resilience (for free)

JIANGXI PINGXIANG PROJECT: WETLAND REHABILITATION TO BE FLOODED DURING HEAVY RAINFALL EVENTS AND USED AS PARK AT NORMAL WATER LEVELS

2. PRC: Hubei Huanggang Urban Environment Improvement Project

Integrated solution to make Huanggang livable – reduce flood risks and improve water quality

- **Huanggang**
  East of Wuhan, along the Yangtze River
  Total population in 2019: 7.37 million
- **ADB Project Loan $100 million** of about $252 million total investment, approved 2014 and currently under implementation
- **Target outcome: Improved urban environment in Huanggang**
  - Reduced return period of seasonal flooding
  - Improved lakes and rivers water quality
- **Project Outputs**
  - Lake and river enhancements with environment facilities operating
  - Solid waste collection and transfer facilities operating and public awareness of solid waste and environmental protection increased
  - Institutional capacity in project implementation and water quality monitor is developed and strengthened

2. PRC: Hubei Huanggang Urban Environment Improvement Project

NBS approach in flood control and water quality improvement

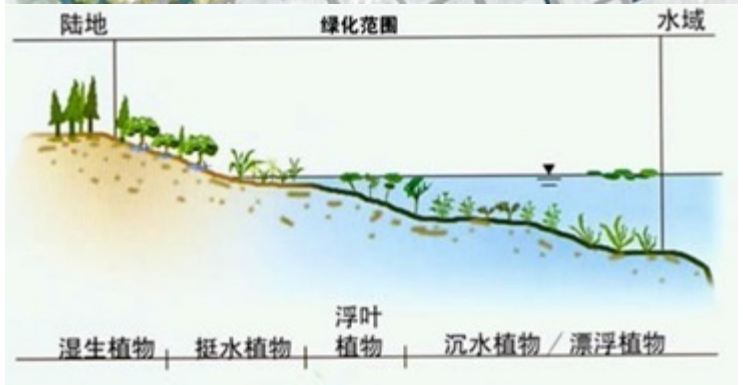
- Ecological flood-retention embankments with vegetated buffer strips
- Create surface-flow constructed wetland in total of 80 hectares Chiye Lake area
- Establish subsurface-flow constructed wetlands to treat nonpoint source pollution
- Ecological measures: aquatic plants, fish species, benthic mollusks
- Install sluice gates and water environment monitoring system
- Enhance water circulation and quality of the entire Xingfu water catchment area
- Install sewer system to separate stormwater and sewage collection in flood-prone river-side communities

Protection of migratory birds

- Yearly water bird survey monitoring program implemented with ornithologist

Herron cluster, Baitan Lake (26 Dec 2020)

Common Kingfisher, Baitan Lake (21 Mar 2021)



3. PRC: Jilin Yanji Low-Carbon Climate-Resilient Healthy City Project

Integrated Solution to make Yanji more livable

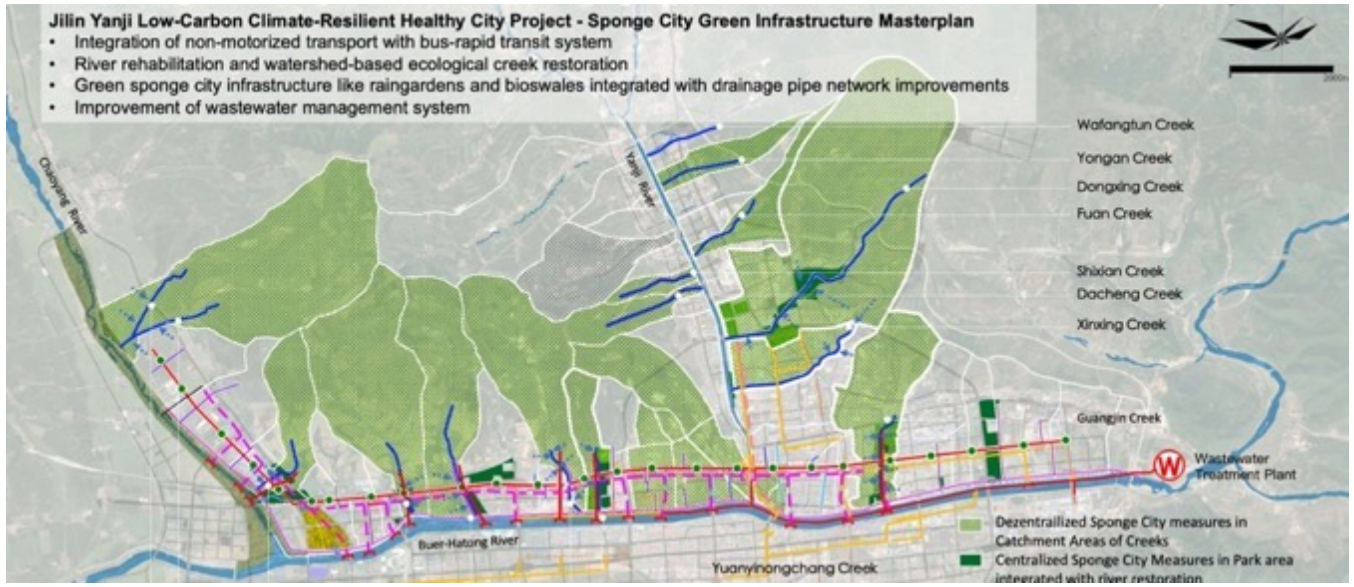
- **ADB Project Loan $130 million equivalent** of $260 million total investment, approved 2019 and currently under implementation
- **First bus rapid transit (BRT) line in the city** Connects major urban functions and areas following ”compact city” and “transit-oriented development” (TOD) principles
- **Improved bicycle and pedestrian networks** and create new small streets and green links
- **Linear green parks as green infrastructure**
- **Improved water supply and wastewater** management.
- **Improved health outcomes, environment and healthy lifestyles** and safe links to schools and hospitals. Health impact assessment and healthy and age-friendly city masterplan during implementation.

Source: Asian Development Bank Project Documents

3. PRC: Jilin Yanji Low-Carbon Climate-Resilient Healthy City Project

Sponge City Green Infrastructure Masterplan

- Based on watersheds and integrated with BRT line and green space and small street systems.
- Integrates new green infrastructure with improving and changing drainage pipe system
- integrates opportunities of green sponge city infrastructure to reduce urban flooding
- River rehabilitation and flood risk management with green river edges
- Combined these actions will increase resilience and improve protection against urban and river flooding



Source: Asian Development Bank Project Documents

3. PRC: Jilin Yanji Low-Carbon Climate-Resilient Healthy City Project

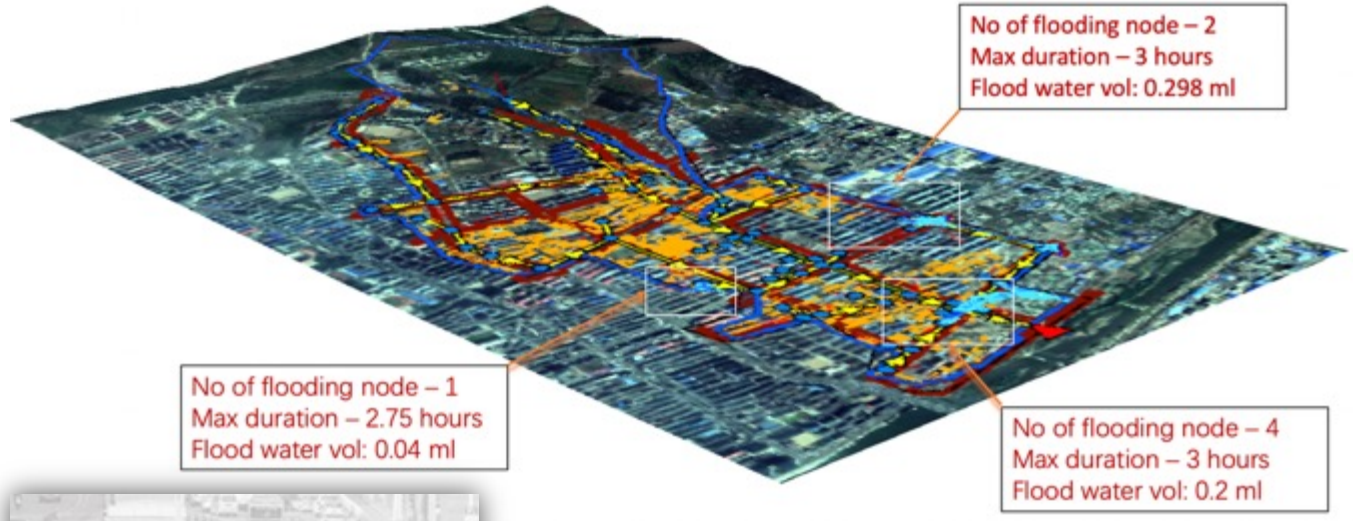
Advanced tools integrating planning & design

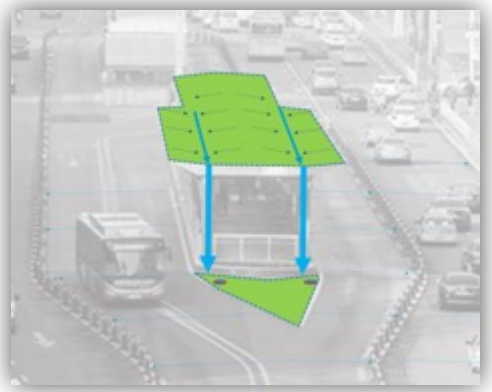
- Systemically integrates gray infrastructure and green sponge city infrastructure to enhance resilience and uses opportunities of integrating transport infrastructure with green sponge city infrastructure

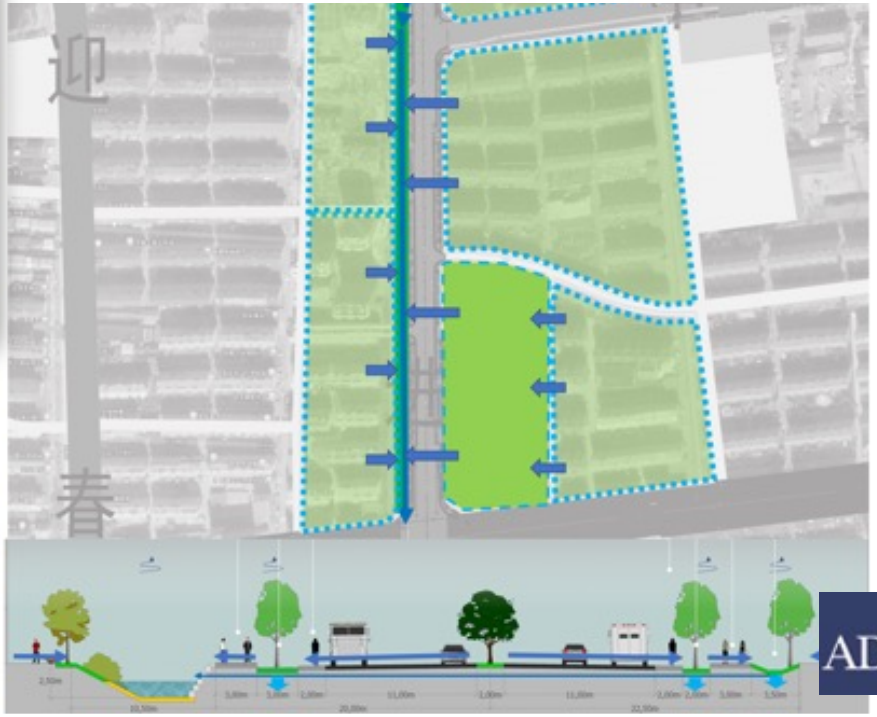
- Integrates a variety of urban and natural functions to optimize planning and design of transport, water supply, drainage and flood risk management and sponge city green infrastructure increasing resilience through ICT systems and user apps

Smart water supply system

- improves resilience, water safety and security, conserving 4.8 million m3 of water resources annually, identifies non-revenue water, smart water meters

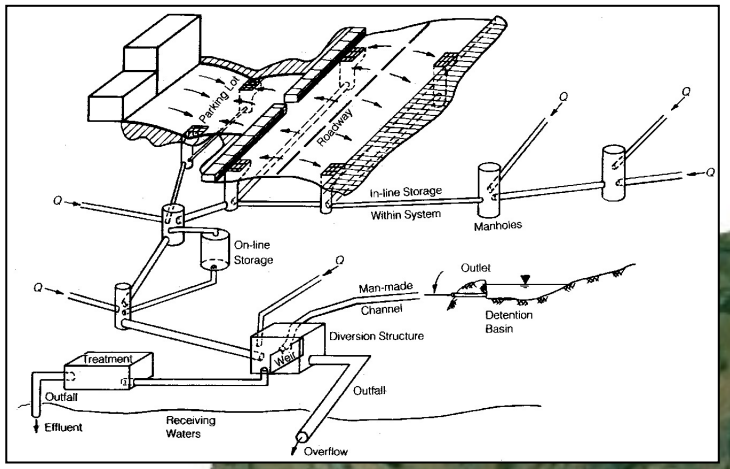


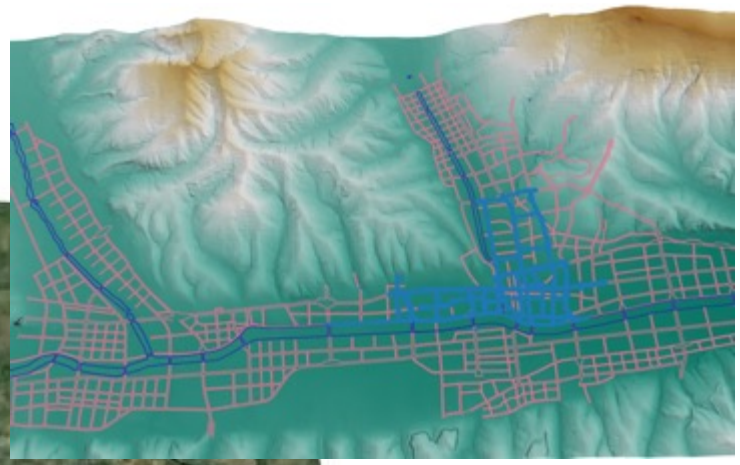




3. PRC: Jilin Yanji Low-Carbon Climate-Resilient Healthy City Project

Applying hydrological and hydraulic models in climate risks assessment and adaptation





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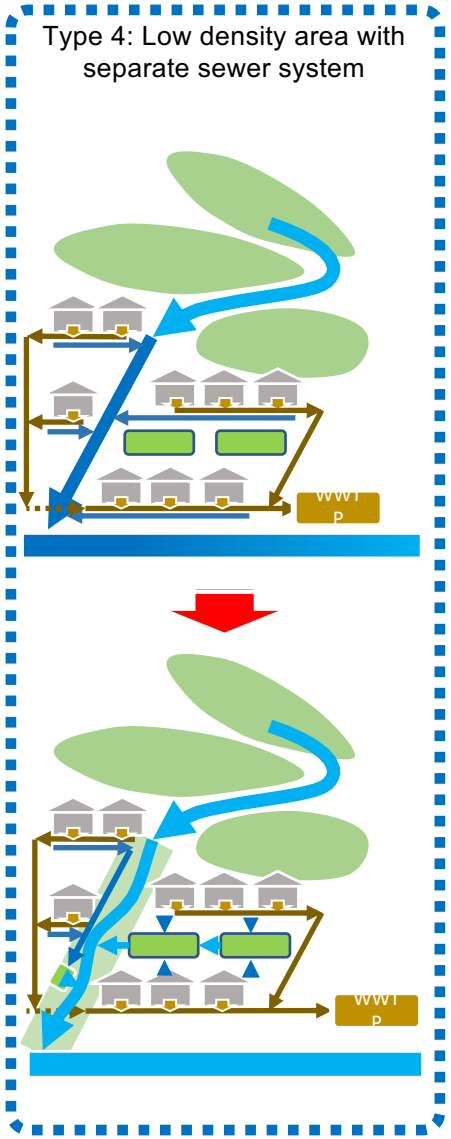
Solution Strategy



Current Situation：

- New district with open spaces
- Pluvial flooing due to Lack of drainage capacity
- Concrete creek without self-cleansing function
- Storm water includs first flush and infiltration water drain directly to creek
- Creek pollution

Solution Strategy：

- Sponge city implementation into open space
- Storm water drains into creek after cleansing and detention of Sponge city measures
- Ecological restoration of creek

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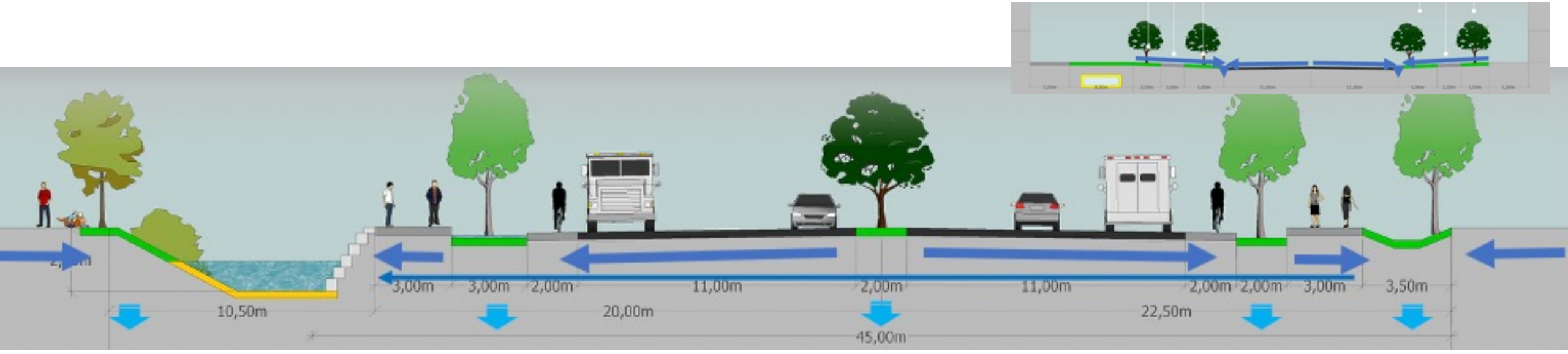

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HIA: Health Impact Assessment
HACAMP: Healthy and Age-Friendly City Action and Management Plan