

# VALUING THE BENEFITS OF NATURE-BASED SOLUTIONS FOR INTEGRATED URBAN FLOOD MANAGEMENT IN THE GREATER MEKONG REGION

## SYNTHESIS REPORT



BIRD OBSERVATION

BIODIVERSITY

BOARDWALK

WETLAND

VIEWING POINT

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## Abbreviations

ARI	average recurrence interval
AQI	air quality index
AWP	Australian Water Partnership
BCA	benefit–cost analysis
BCR	benefit–cost ratio
BMA	Bangkok Metropolitan Administration (Thailand)
CBD	central business district
CCMC	Climate Change Management and Coordination Division (Thailand)
CRCWSC	Cooperative Research Centre for Water Sensitive Cities
CSR	Corporate Social Responsibility
DFAT	Australian Government Department of Foreign Affairs and Trade
DOC	Department of Construction (Vietnam)
EEC	Eastern Economic Corridor (Thailand)
EECDP	Eastern Economic Corridor Development Plan (Thailand)
FAR	Floor Area Ratio
GEDSI	gender equality disability and social inclusion
GHG	greenhouse gas
GIS	geographic information system
HCMC	Ho Chi Minh City
ICEM	International Centre for Environmental Management
IFC	International Finance Corporation (Vietnam)
INFFEWS	Investment Framework for Economics of Water Sensitive cities
IOT	Internet of Things
IUFM	Integrated Urban Flood Management
LEED	Leadership in Energy and Environmental Design (Vietnam)
NAP	National Climate Adaptation Plan (Thailand)
NCCC	National Committee on Climate Change Policy (Thailand)
NbS	nature-based solutions
NESDC	Office of the National Economic and Social Development Board (Thailand)
NESDP	National Economic and Social Development Plan (Thailand)
NGOs	non-government organizations
NPV	net present value
OECD	Organisation for Economic Cooperation and Development
ONEP	Office of Natural Resources and Environmental Policy (Thailand)
ONWR	Office of National Water Resources (Thailand)
PPP	public–private partnership
UddC	Urban Design and Development Centre (Thailand)
UNFCCC	United Nations Framework Convention on Climate Change

# 1 Key messages

Our future is urban. Cities fuel our economies, nurture innovation and can improve quality of life. More than half of the world's population already live in urban areas – and this number is expected to rise to 68% by 2050.<sup>1</sup> The need for investment to support this growth is significant and there is increasing consensus that the infrastructure solutions that served us well in the past may not be sufficient to deliver the climate resilient future cities we need at an affordable cost.

Rapidly rising urbanization rates – particularly in developing countries – are challenging cities to provide services for expanding populations, while contending with the impacts of climate change. In the Lower Mekong Basin, future exposure to climate change effects including flooding, sea level rise, heat, drought, storms and shifts in vegetation could damage \$18 billion worth of infrastructure and decrease economic productivity by \$16 billion annually by 2050.<sup>2</sup> Disadvantaged groups including women, children, the elderly, people with disabilities and homeless people are often the most affected.

Compared with conventional 'grey' infrastructure, nature-based solutions (NbS) or green infrastructure (e.g. constructed wetlands, raingardens and bioswales) can require less upfront investment, are more scalable and flexible and generate a range of environmental, economic and social co-benefits beyond flood management. NbS can also be integrated with existing and planned infrastructure to form hybrid solutions that not only improve urban flood management but enhance climate resilient urban development more generally. Integrated Urban Flood Management (IUFM) provides a framework for identifying, comparing and funding hybrid green–grey solutions. IUFM empowers public, private and community action to respond to local, city and catchment scale needs and opportunities. However, it can be difficult for decision-makers to value and compare NbS hybrid and conventional solutions. Municipal funding can also be limited, and local data about the costs and benefits of NbS is often lacking.

In this study, national and international experts came together to apply the IUFM approach to 4 case studies in Thailand and Vietnam. The case studies examined sites in 2 major cities – the Sukhumvit district in Bangkok and Tam Phu Park in Ho Chi Minh City (HCMC) – and 2 regional centres – Rayong and Phu Quoc. Each context had unique challenges and opportunities, from the global city and international tourism aspirations of Bangkok and HCMC, to the island economy of Phu Quoc, and Rayong's role in Thailand's Eastern Economic Corridor. The case studies illustrated the flexibility of NbS and quantified the economic, social and environmental the value NbS can add to existing infrastructure and strategies.

In particular the project highlighted the following key points:

- By applying the IUFM retreat, adapt, defend approach, NbS displayed significant potential for flood mitigation benefits in all 4 cases studies. They also offered broader benefits such as improved water quality, thermal comfort, biodiversity, amenity and recreation, which in turn can boost the local economy and ensure investments deliver value every day as well as during extreme events. The Phu Quoc case study also demonstrated the circular economy opportunities.
- The flexibility and scalability of NbS enable hybrid solutions that respond to local context and add significant value to high density urban areas through:

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<sup>1</sup> United Nations, Department of Economic and Social Affairs, Population Division (2019), [World urbanization prospects: the 2018 revision](#), New York: United Nations.

<sup>2</sup> J Talberth and K Reytar (2014), [Climate change in the Lower Mekong Basin: an analysis of economic values at risk](#), report prepared for USAID Mekong Adaptation and Resilience to Climate Change, Washington DC: World Resources Institute.

- large NbS assets (parks) and smaller scale distributed assets (e.g. swales, tree pits, planter boxes, green roofs and walls) working together to form an integrated green precinct (e.g. Sukhumvit case study)
- networks of linear NbS assets integrated into urban roads and transport corridors, as well as retrofitting of grey areas such as car parks when large green spaces are limited (e.g. Rayong case study)
- a catchment-scale perspective identifying upstream action for downstream urban benefits and lower overall costs (see Phu Quoc, Sukhumvit and HCMC case studies)
- water cycle solutions for all four all cases studies including flood responses that also create water supply sources and decentralised solutions for sewage and drainage management that improve both water quality and quantity outcomes and support a longer term transition to separate drainage and sewage systems.
- circular economy outcomes enabling better management of solid and liquid waste (see Phu Quoc case study)
- NbS enable public, private and community-based partnerships that can support:
  - more efficient project delivery
  - a broader range of options for funding and financing investments and maintaining assets over their useful life.
- Better understanding the distribution of costs and benefits of IUFM solutions can create opportunities for more inclusive outcomes and more informed, efficient, effective and fair decisions about who should pay what, how and when.

The case studies provide an initial strategic assessment. Concept designs show what is possible and economic assessments provide the case for further investigation. International benchmarks and experience were used when site specific information was not available highlighting the benefits of regional collaborations and information sharing. Each case study includes recommendations for further investigation and action; common themes include the importance of aligned policy, enabling regulation, technical capacity and community/private sector activation. National and regional knowledge exchange and shared learning was also a critical element of the project.

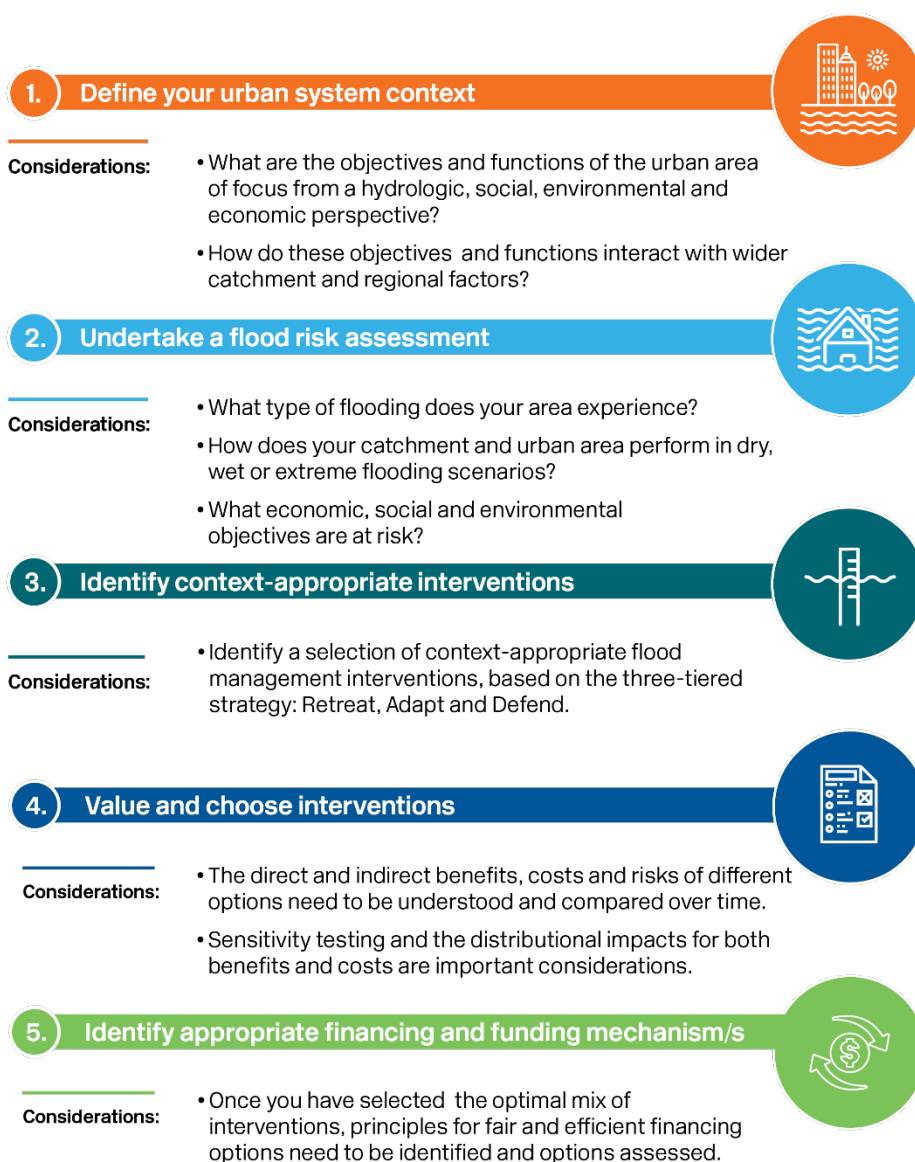
Taken together, the case studies show the value that IUFM including NbS can bring to urban flooding responses and more climate resilient urban development. They also build a case for further collaboration and wider, smarter application across the greater Mekong region.

## 2 Context, need and approach

Rapid urbanization and industrialization are increasing the challenges of providing services to growing urban populations while also managing the effects of climate change. For example, already the world's most common natural disaster, flooding is forecast to occur more frequently and cause more damage in future years. Countries in the Mekong region, such as Thailand and Vietnam, are among the world's most exposed countries.

Mounting evidence suggests conventional infrastructure approaches that have served communities well in the past may not deliver the climate resilient cities we need at an affordable cost. IUFM offers a broad range of solutions that can respond to the unique needs of a given catchment and community. These solutions can include conventional 'grey' infrastructure (e.g. dams, dikes, levees), nature-based or 'green' solutions (e.g. constructed wetlands, raingardens, bioswales). They also include both structural and non-structural solutions (e.g. behavior change programs and incentives, land use planning and building requirements, flood warning systems, emergency planning and management).

The IUFM approach provides a framework for identifying, comparing, selecting and funding the best portfolio of grey, green and non-structural solutions, based on leading international research, established valuation and comparison methodologies and local expertise. The approach follows a 5-step process (Figure 1).



### Figure 1: Framework to identify, value, and realise values of nature-based solutions.

Benefit–cost analysis (BCA) was adopted for step 4 because it is a rigorous and accepted methodology for comparing the value to the community of different options. It can be used for a range of purposes including initial scoping of strategic concepts, detailed comparison of options, and review of whether a project, program or regulation has delivered the promised benefits. The CRC for Water Sensitive Cities has developed and trialled the innovative Investment Framework for Economics of Water Sensitive cities (INFFEWS) which provides a BCA Tool and Value Tool for valuing the non-market benefits offered by NbS.<sup>3</sup>

Four case studies from Thailand and Vietnam demonstrate how to apply the tools and in practice. They add to work already done in China and Australia and were selected using the following criteria:

1. **Demonstration potential and relevance to national stakeholders** including consideration of current flooding and broader policy and strategic issues. National and project partner existing investment priorities were also considered as well as the potential for NbS to add value to identified projects.
2. **Data availability and accessibility including** contextual and project specific data including socio-economic, demographic and GEDSI (gender equity, disability and social inclusion) issues, information on historical floods and other natural hazards, local and downscaled climate change projections, land use patterns and masterplans. This criterion also included the availability of data on costs and benefits of conventional engineering measures to improve flood resilience either in the same project or in similar settings to inform comparative analysis with NbS.
3. **Potential to assist for replication and upscaling**, by evaluating opportunities within the city/province, the country and the region to replicate and upscale application of the valuation tool, results and lessons from the case study including the selected NbS. This criterion also included potential to influence planning processes, norms and technical standards.

Strong stakeholder engagement and co-creation of solutions was also critical to the case study approach. As well as promoting IUFM approaches, the project's parallel goal was to build capacity and create a community of practice of national champions who have the tools and knowledge to identify, evaluate and quantify NbS within a robust economic framework. Capacity building and knowledge exchange events were held throughout the project to present results and seek feedback about each step of the IUFM process.

Key project outputs included:

- this synthesis report for policy makers and planners
- the 4 case study reports:
  - *The Sukhumvit green triangle, Bangkok*
  - *A cool green central business district for Rayong*
  - *Tam Phu Park, Thu Duc City – A multifunctional urban wetland*
  - *Duong Dong Freshwater Wildlife Conservation Park, Phu Quoc.*
- Thai and Vietnamese IUFM technical guides for practitioners
- training materials and a regional conference to share experience and build regional capacity and collaboration.

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<sup>3</sup> Cooperative Research Centre for Water Sensitive Cities (2020), *INFFEWS Benefit: Cost Analysis Tool*, Melbourne: CRCWSC. Also see <https://watersensitivecities.org.au/content/inffews-value-tool/>



### 3 Case study overviews

This section summarizes each case study and the BCA results. The analysis represents an initial strategic assessment, and while each case study is unique, the potential benefits are clear in each case.

Table 1 presents the features of the BCA for each case study. The ‘base case’ identifies the comparator for the hybrid approach in each case study. Different approaches were used to illustrate the different options available to policy makers and planners.

Where a decision has already been made to proceed with a project it is possible to look at the additional benefits NbS can provide. For example, for Sukhumvit and HCMC case studies, the base case is the pre-existing masterplan for the area (in Sukhumvit, the Benjakitti Forest Park Phase 2 and 3, and in HCMC, the Tam Phu Park Masterplan). That is, the BCA compares the *additional* benefit that hybrid measures can bring, on top of the features in the masterplan.

It is also possible to use BCA to consider the *total*, standalone benefit of a hybrid option relative to doing nothing or instead of a conventional solution. For Rayong, the hybrid strategy is compared with the costs and benefits of a ‘do nothing’ scenario. For Phu Quoc, 2 BCAs were carried out – one for the pre-existing conventional solution for flood protection (dredging and widening the Duong Dong river), and one for the alternative hybrid strategy (the wetland conservation park).

#### Key economic terms

**Net present value:** Calculates today’s value of a future stream of payments over the entire lifecycle including costs and benefits

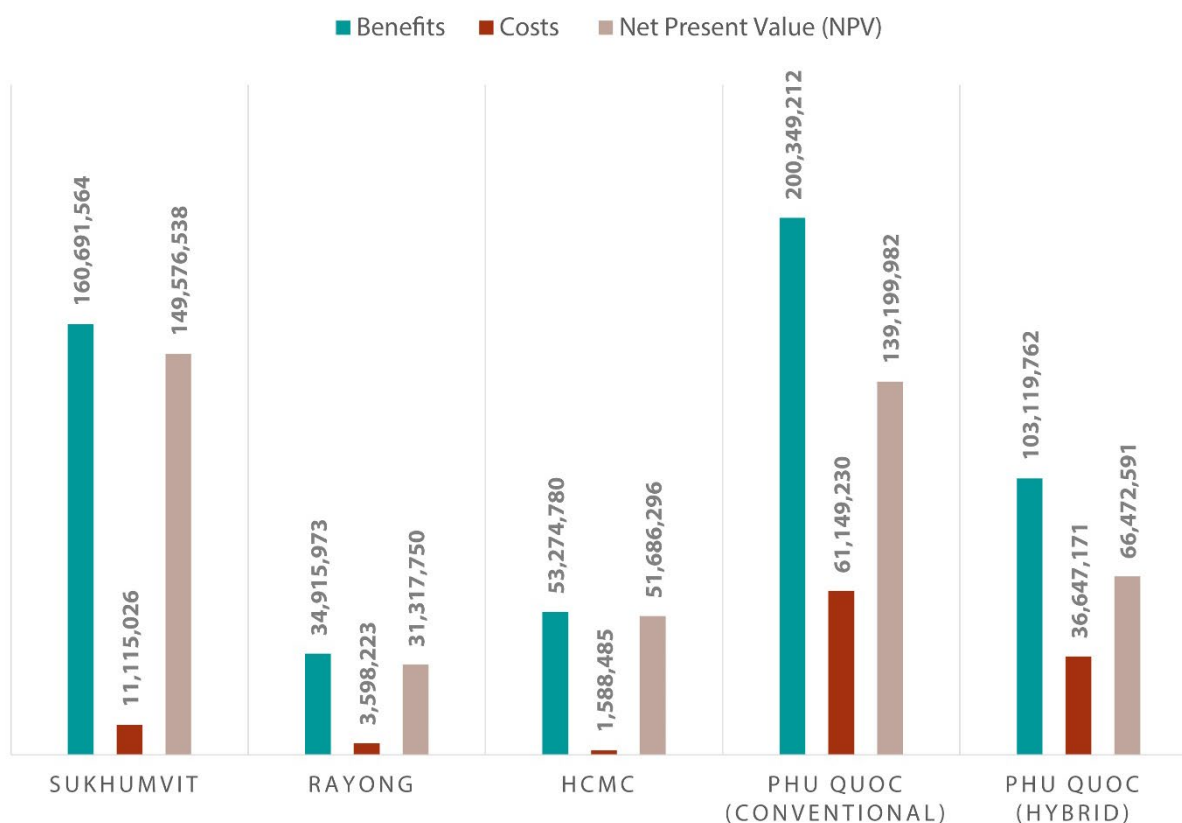
**Benefit–cost ratio:** Compares the present value of all benefits with the cost. For every dollar spent, the BCR ratio gives you how much you will get back in benefits

**Table 1: Features of the BCA for each case study<sup>4</sup>**

	Sukhumvit	Rayong	HCMC	Phu Quoc (conventional)	Phu Quoc (hybrid)
<b>Base case</b>	Masterplan	Do nothing	Masterplan	Do nothing	Do nothing
<b>Type of BCA</b>	Comparative	Standalone	Comparative	Standalone	Standalone

Figure 2 summarizes the results of the economic assessment, showing the total costs, benefits and net present value of each case. The benefit–cost ratios (BCRs) for each project are: 14 for Sukhumvit; 9 for Rayong; 36 for HCMC; around 3 for both the conventional and solutions hybrid solution for Phu Quoc.

<sup>4</sup> All values are provided in USD and have been adjusted to present value.



**Figure 2: BCA results for each case study.**

*Source: Project team.*

The strong results for Sukhumvit and Rayong provide a clear incentive for action. The BCR results for Phu Quoc also present a strong case for action, particularly given the island's high flood risk means doing nothing is no longer an option. The conventional option offers very high flood protection benefits, but at a very high cost. In contrast, the hybrid option still offers a strong level of flood protection compared with the base case, while offering a range of additional co-benefits. This lower cost may also enable inclusion of additional flood mitigation measures and/or free public funds for spending on other investment priorities.

In HCMC, the hybrid option is actually lower cost than the conventional option in the masterplan, while providing a range of co-benefits at the same time. Each case study considered the costs and benefits from the perspective of the community overall and from the organisation assumed to be leading the project. In the HCMC case study, the benefits to the lead organization were clear (with a BCR of 22) while in other cases the direct net benefits to the lead organisation were more marginal (BCRs around 1) even though the net benefits to the community overall (including the lead and other stakeholder organizations) were significant. This highlights the importance of a whole-of-community perspective.

The 4 case studies provide an initial strategic assessment. Given a number of material data gaps assumptions were made and international benchmarks used. Sensitivity testing was therefore important to establish how robust the results and conclusions of each case study were to varying these assumptions. The overall benefits offered by NbS were found to be significant in each case study under a broad range of sensitivities, providing confidence in the conclusions and illustrating the application of IUFM in data constrained contexts. The sensitivity testing also highlighted priority areas for further investigation.

Further details about each case study are provided below.

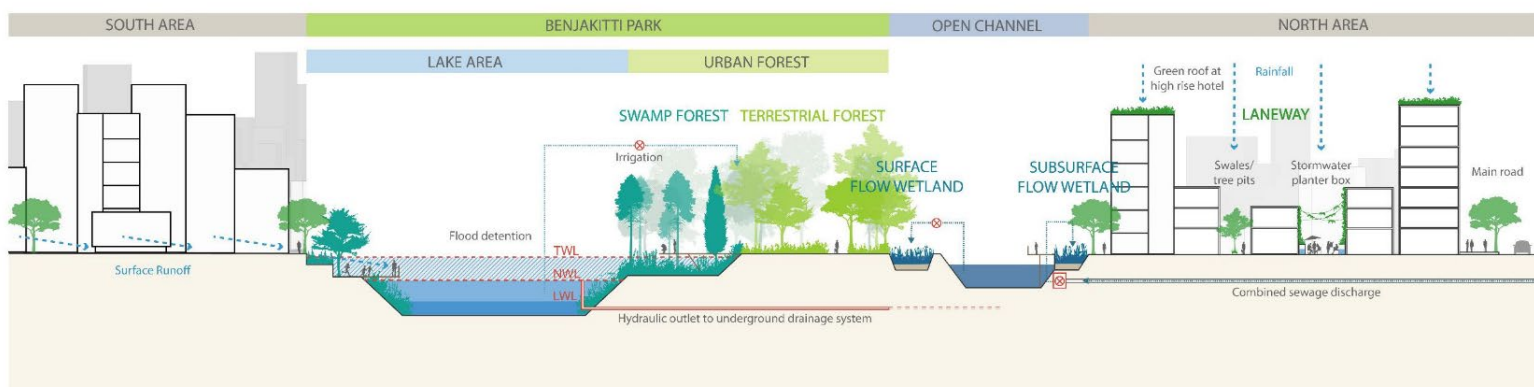
## The Sukhumvit Green Triangle, Bangkok

*The vision for this case study is a 'green triangle', connecting Benjakitti Park, Lumpini Park and the dense, urban area to the north of Benjakitti Park via a network of multifunctional green space that showcases world class future city solutions in Bangkok, Thailand.*

In October 2020, Thailand's Treasury Department and Royal Thai Army initiated Phase 2 and 3 of the Benjakitti Forest Park in Sukhumvit to transform the site of a former tobacco factory with an innovative ecological design. Alongside this, municipal agencies accelerated the renovation of a green bridge connecting the park to the nearby Lumpini Park – one of the city's largest and most popular.

This case study builds on these plans to propose 3 main features:

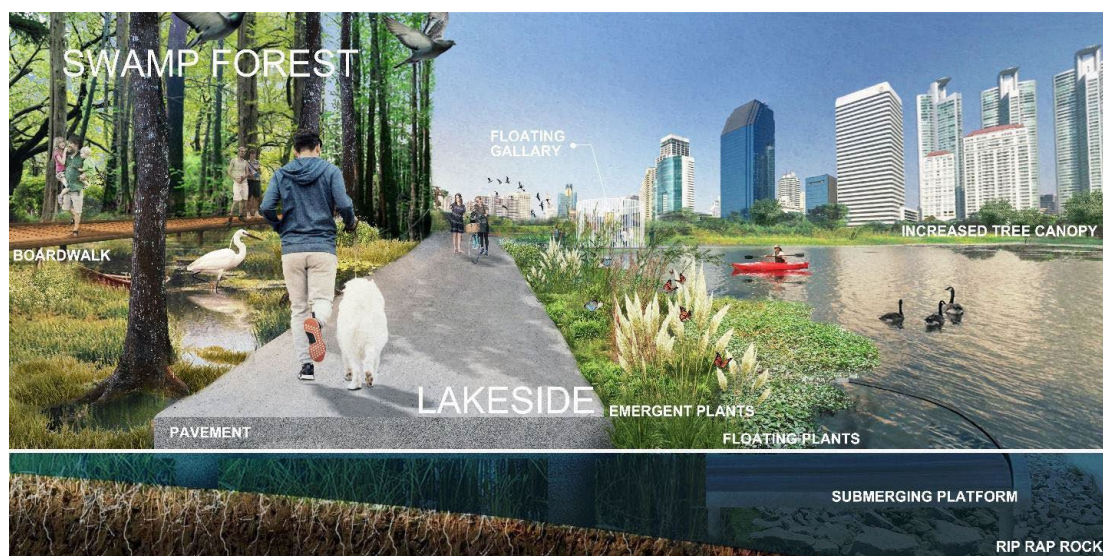
1. **A multifunctional Benjakitti Park.** The design incorporates improvements to the open channel in the north of the existing park site, a linear subsurface flow wetland to improve water quality in the channel and intercept direct wastewater discharged from the northern area, retrofitting of the lake for greater flood detention capacity and amenity with a terraced design and wetland species that can withstand full or partial inundation, and stormwater harvesting that can be recirculated and used for park irrigation and non-potable water supply for park learning centres.
2. **Precinct and small-scale NbS in Sukhumvit to the north of the park.** A network of NbS including green roofs, tree pits, swales and stormwater planter boxes will be installed through partnerships with the private sector and local communities to mitigate frequent flooding, reduce combined sewer overflows into the open canal, and improve human thermal comfort and amenity for local residents and tourists.
3. **A 'green triangle'** that connects the greened urban area to Benjakitti Park and Lumpini Park to the west to create a cool, walkable and ecologically rich central zone in Bangkok's Sukhumvit District, which can be traversed using an innovative Internet of Things enabled 'cool lines' platform.



**Figure 3: Transect overview of the hybrid approach for Sukhumvit.**

Source: Project team.





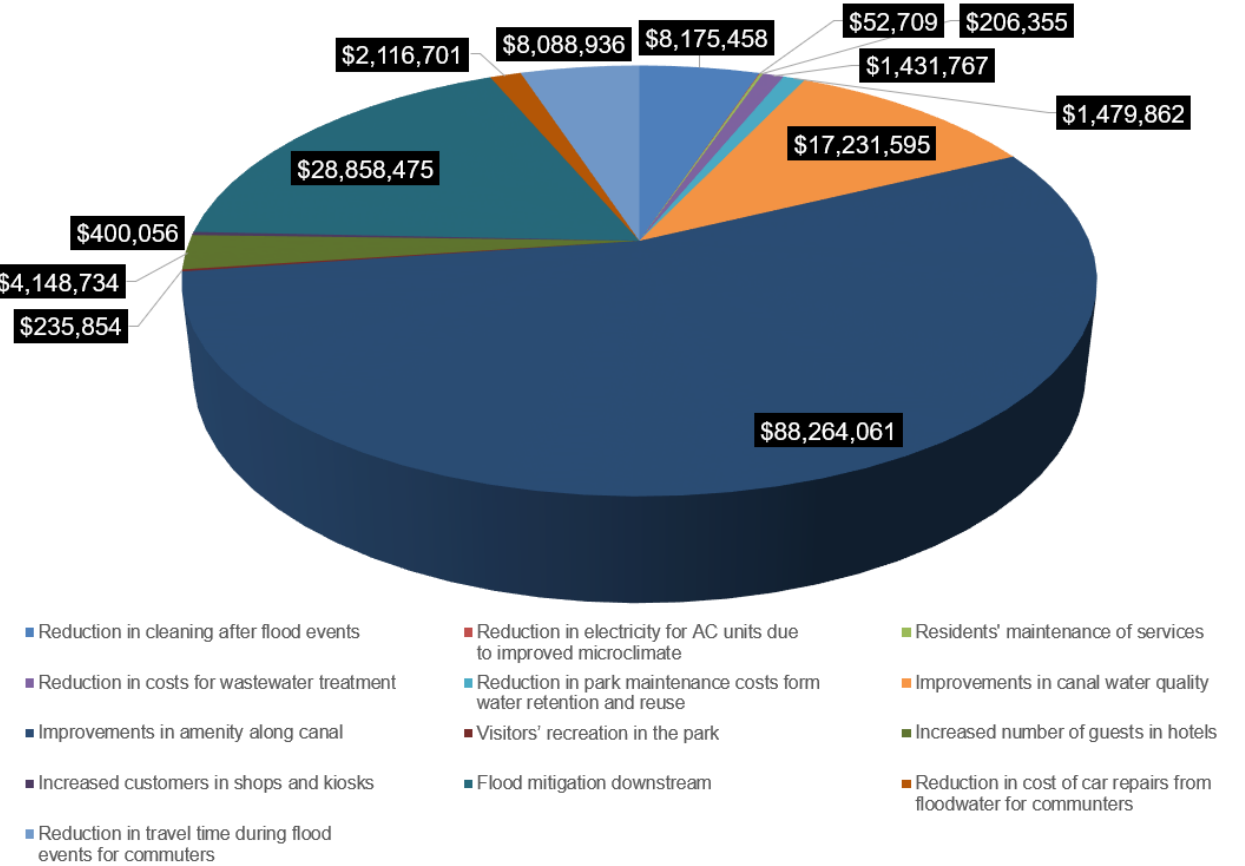
**Figure 4: Illustration of the multifunctional Sukhumvit wetland park under different climate conditions.**

Source: Water Sensitive Cities Australia.



This case study supports the goal of upscaling NbS throughout Thailand by highlighting the additional value of NbS and decentralized initiatives in large investments. The hybrid-NbS assets would reduce flooding in a critical business and residential area, improve water quality in the park and local area, improve thermal comfort, provide a network of rich urban ecology, and enable new amenity and recreation, thereby boosting the local economy and aligning with Bangkok’s world class future city ambitions.

Results indicate a strong overall BCR of 14 over 20 years, with a net present value (NPV) of approximately USD 150 million. Put another way, the ratio of benefits to the community for every dollar of investment is significant, at 14. The largest individual benefit is improved amenity along the canal from surface and subsurface flow wetlands on the northern park perimeter, with the benefit coming largely from increased property values near the canal (Figure 5).



**Figure 5: Sukhumvit case study benefits summary.**  
 Source: Project team.

As well as private sector engagement through CSR schemes, funding and financing mechanisms include targeted investment that leverages existing incentivization schemes such as the Floor Area Ratio (FAR) Bonus under the 2013 Bangkok Comprehensive Plan. Engagement with local neighborhoods to install and maintain NbS is also recommended, to help to create local champions with a shared vision for a green, prosperous and climate resilient Bangkok.

As a whole, this case study provides an integrated package or portfolio of large and small investments ensuring the whole is greater than the sum of the parts. It also highlights the importance of piloting innovative solutions to establish proof-of-concept, and where necessary, updating planning and regulations to create an enabling environment for upscaling successful sites.

## A cool green central business district for Rayong

*The vision of this case study is streetscape transformation throughout Rayong City's central business district, incorporating a network of green assets to improve thermal comfort, mitigate flooding and increase natural infiltration.*

Rayong is Thailand's leading industrial hub, with the nation's highest per capita GDP. Under the Eastern Economic Corridor Development Plan, Rayong will be the focus of accelerated economic growth to develop the region as an arterial hub for trade, investment, research and innovation, and regional transportation. A business-as-usual approach cannot support this growth in a way that protects the environment and the health and wellbeing of communities.

The strategy outlined in this case study includes 5 main features:

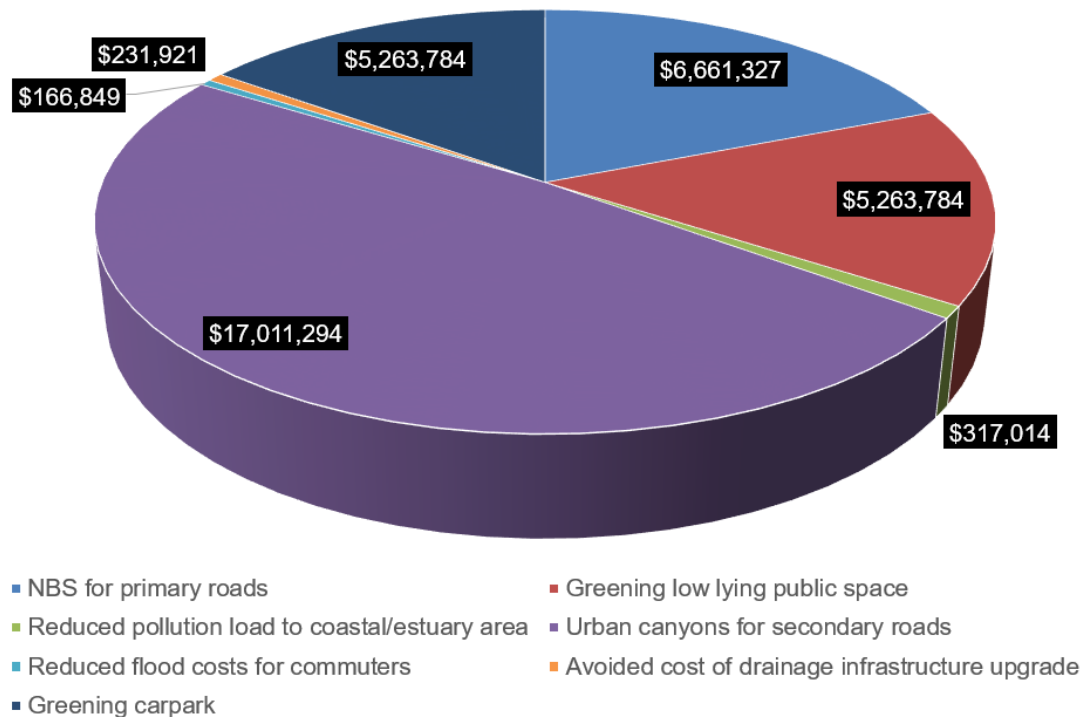
1. **Water sensitive urban design on primary roads** for a green transport network and to improve flood management on critical transportation routes (Figure 6)
2. **'Urban canyons'** on key commercial/neighborhood streets to increase canopy cover, support urban cooling and improve human thermal comfort
3. **Green, cool shopping hubs** supported by rainwater harvesting tanks on roofs of large commercial buildings to mitigate localized flooding and reduce combined sewer overflow
4. **Greening of low-lying public space** including carparks to increase multifunctionality, support urban cooling, improve human thermal comfort, increase natural infiltration and reduce localized flooding
5. **Rayong 'cool lines' smart platform** to enhance community and tourist experiences, allowing visitors and residents to find the greenest and coolest routes.



**Figure 6: Illustration of proposed NbS for primary roads in Rayong.**

*Source: Water Sensitive Cities Australia.*

Results show a strong overall BCR of 9.7 over 20 years, and an NPV of around USD 31 million. This result shows NbS assets can create significant value for a broad range of stakeholders, including local communities, commuters, visitors, the private sector and government implementing agencies (Rayong Municipality, the Department of Highways, and the Department of Rural Roads).



**Figure 7: Rayong case study benefits summary.**

*Source: Project team.*

This case study also highlights the advantages of a phased approach. The strategy starts with secondary roads and then one primary road as a pilot, with additional roads retrofitted at 5-year intervals, concluding with Sukhumvit Road in 2032. This approach manages risk, spreads out costs and capitalizes on regular planned maintenance works. It also builds trust in the measures and promotes learning from the pilot phases to inform future development, including potential national level building code reform.

Engaging the private sector – including small businesses in Rayong’s CBD – and local communities is essential to construct the measures and to define maintenance roles and responsibilities. Several creative ways to engage and incentivise locals emerged from Expert Exchange sessions. Examples identified through engagement with local and national experts included building on local beliefs by planting a family tree to support urban greening efforts and possible partnerships with the Ministry of Culture.

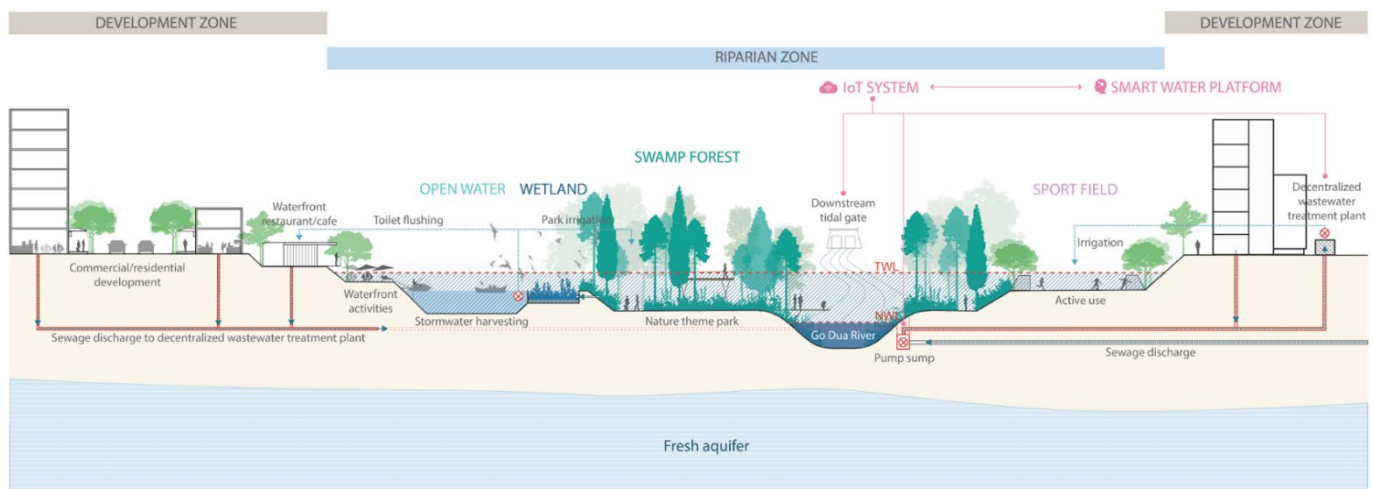
## Tam Phu Park, Thu Duc City – A multifunctional urban wetland

*The vision of this case study is to transform Tam Phu Park in Ho Chi Minh City's Thu Duc City innovation hub into Vietnam's first Internet of Things enabled multifunctional urban wetland park.*

HCMC authorities have high ambitions for Tam Phu Park. Under the current area masterplan, the site will be transformed into the 'green lung' of the new Thu Duc City innovation hub – a landscaped area with recreational and leisure facilities, tree cover to provide cool urban temperatures, food and beverage services and some flood protection infrastructure with the construction of stormwater drainage pipes. The masterplan is the baseline scenario for this case study.

The proposed hybrid strategy builds upon this plan, proposing a multifunctional urban wetland park that is consistent with the long-term vision that combines NbS, leading technology and private sector collaboration (Figure 8). The strategy will reduce costs and increase benefits via a wetland forest and riparian area. The terraced design will contain species that can withstand inundation during high water levels and provide dynamic recreational space and rich ecological habitat for visitors. Constructed wetland recirculation and a decentralized wastewater treatment plan will improve water quality, and stormwater harvesting will provide water to irrigate the park. An Internet of Things smart water platform will optimize water infrastructure operation and enable pre-emptive action to protect against extreme events.

The approach also proposes residential development within the park via an innovative 'eco-social' housing scheme. The scheme will offer low- and mid-income housing for resettled local residents, and some high-end luxury developments, all of which will benefit from landscaping works and showcase sustainable building techniques. This scheme would provide a strong draw for talent to the area in line with Thu Duc City's innovation hub aspirations. It will also reduce disruption and the cost of relocating existing park residents. Private engagement should be informed by an assessment of risk, risk allocation, governance arrangements and objectives.

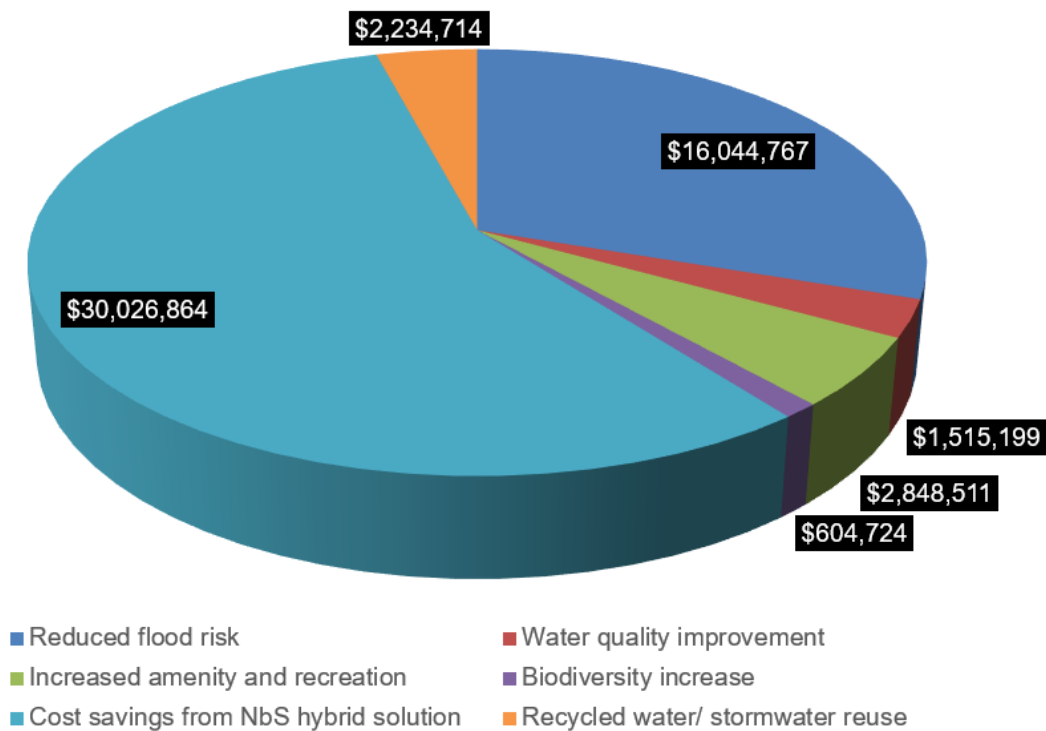


**Figure 8: Transect overview of the hybrid approach for Tam Phu Park.**

*Source: Project team.*

Results of this initial strategic assessment over 40 years show a very strong overall BCR of 36, with a BCR of 22 for the project organization (the government implementing agency). Two benefits account for the majority of those provided by the hybrid solution: the reduced capital and maintenance costs from maximising multifunctionality and introducing more natural design, and the reduced flood risk inside the park and for downstream communities (Figure 9).





**Figure 9: HCMC case study benefits summary.**

*Source: Project team.*

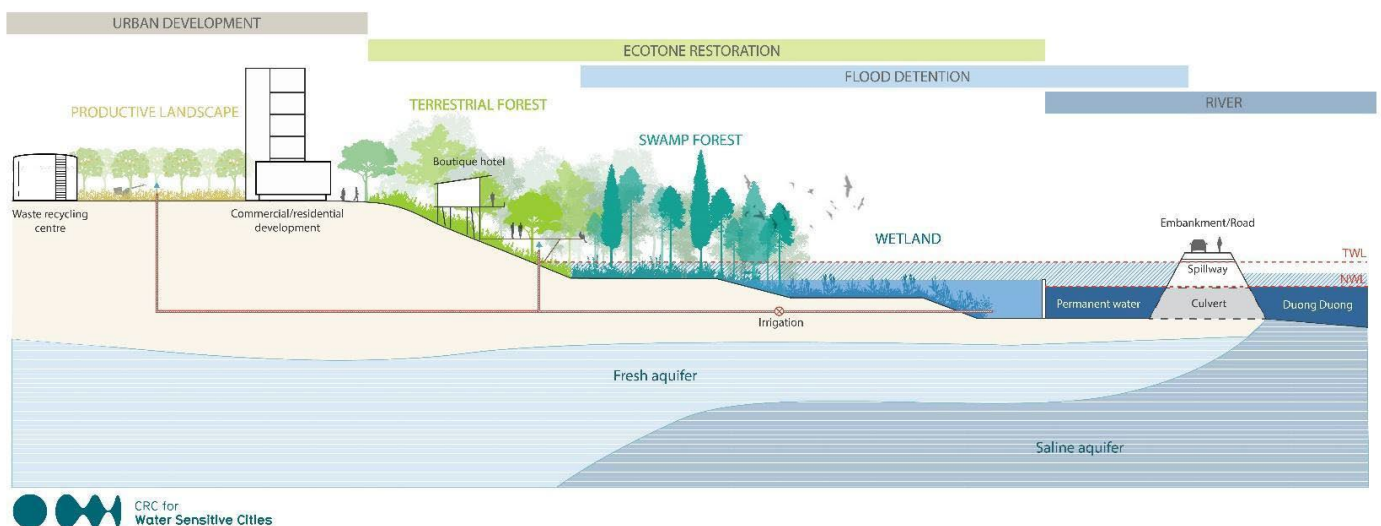
This case study demonstrates hybrid solutions can not only bring significant community benefits, but also reduce upfront and ongoing costs to government. Innovative measures like smart systems and ecological design under fit-for-purpose public–private arrangements can ease the burden on public agencies and support delivery at scale. Piloting and demonstration is necessary to provide proof-of-concept and Tam Phu Park is an opportune site to do so.

## Duong Dong Freshwater Wildlife Conservation Park, Phu Quoc

*The vision of this case study is enhanced flood management via a multifunctional freshwater wildlife conservation park, presenting a unique draw for tourists, a valuable recreational space for residents of Duong Dong ward and leading the way in demonstrating circular economy and sustainability principles in Vietnam.*

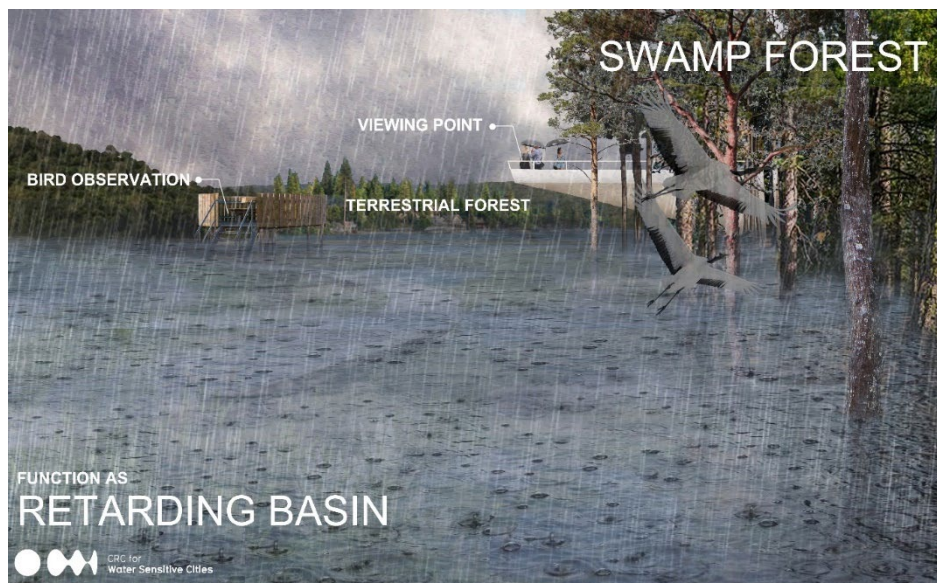
As a closed island system, and a leading national and international tourism destination, Phu Quoc faces unique challenges and opportunities. However, if mounting problems with flooding, water supply, water demand, pollution and waste management cannot be urgently addressed, its communities as well as its tourism industry will suffer.

Flood risk in Duong Dong Ward, Phu Quoc is high, and doing nothing is no longer an option for local authorities. This case study considers the costs and benefits of both a conventional solution for flood mitigation – dredging and widening Duong Dong River which flows all the way through downstream Phu Quoc City – and a hybrid approach – developing a multifunctional freshwater wildlife conservation park linked with a waste recycling facility (Figure 10 and Figure 11).



**Figure 10: Transect overview of the hybrid approach in Phu Quoc.**

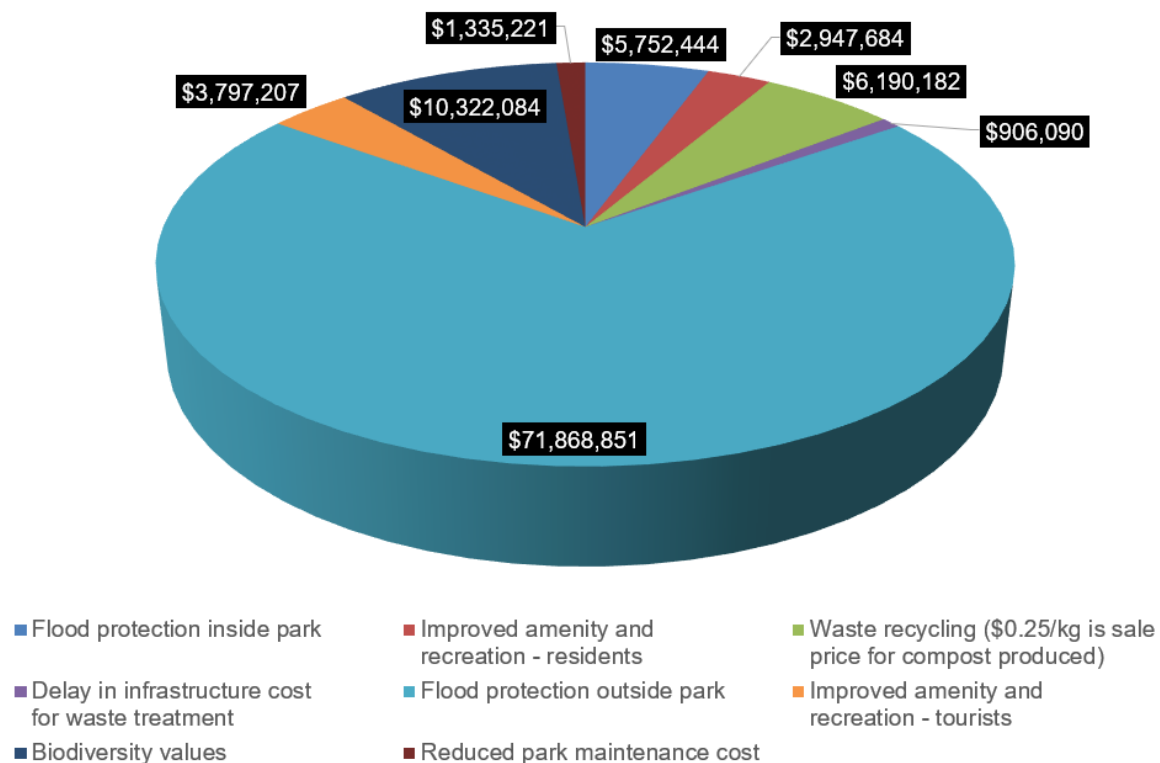
Source: Project team.



**Figure 11: Illustration of Phu Quoc Wetland Conservation Park under different climate conditions.**  
Source: Water Sensitive Cities Australia.



This strategic assessment suggests both options will add value to the community but in very different ways. The conventional approach provides a stronger overall BCR of 3.3 with an NPV of USD 139 million, but at a much greater cost. The hybrid approach has a BCR of 2.8 and an NPV of USD 65 million.



**Figure 12: Phu Quoc case study hybrid benefits summary.**

Source: Project team.

Results illustrate the choice between *scale and scope* which is often part of comparing conventional and hybrid solutions. While the conventional approach offers significant benefits in terms of flood mitigation, the hybrid solution offers additional co-benefits, including cost savings from waste disposal, and significant amenity, recreational and biodiversity benefits to park residents, residents of the wider Phu Quoc City and tourists. In addition, the hybrid solution includes more options for funding and has a lower financing requirement. This lower cost may enable inclusion of additional retreat adapt or defend flood mitigation measures and/or free public funds for spending on other investment priorities. Ultimately, policy makers can decide how to best allocate scarce resources. This initial strategic assessment also highlights the value of further investigating and applying the IUFM approach.

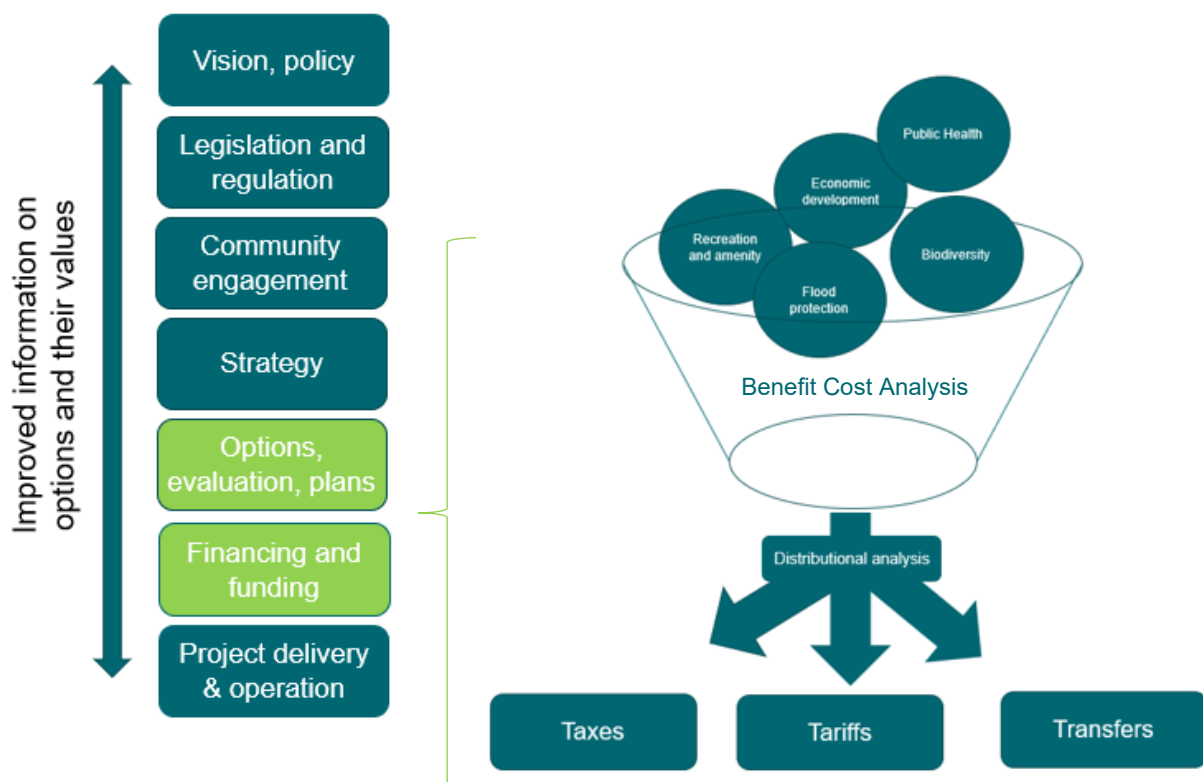
This case study also attempts to go beyond water management to show how circular economy thinking can apply to both water and waste management and present integrated solutions. Island wide, Phu Quoc should consider how to minimize imported resources and use its existing resources more efficiently and sustainably. The goal should be a self-sustaining island that promotes inclusive development, safeguarding the environment and the needs of local communities as well as growth of the tourism sector. Circular economy approaches including hybrid solutions can present ‘win-win’ solutions to balance competing needs and create opportunities for public-private partnerships and long-term community value.



## 4 Recommendations and future opportunities

The case studies undertaken as part of this project have focused on illustrating a broad range of NbS options, valuing their costs and benefits and using a better understanding of the distribution of costs and benefits to inform consideration of a broader range of funding options. In doing so the case studies have illustrated the potential benefits of wider application of NbS. In particular, greater integration of NbS with existing and planned infrastructure to form hybrid solutions can not only improve urban flood management but also increase climate resilience and use available funding to unlock a broader range of benefits and a greater level of community value.

However, achieving larger scale application requires alignment of a range of elements spanning policy, regulation, strategy, technical capability as well as private and community sector support. While focused on options evaluation and funding (shown in light green in Figure 13), the case studies also highlight a number of other areas that are either supporting or constraining up-scaling of NbS.



**Figure 13: Scaling up application of NbS requires alignment of policy and practice**

### Vision, policy, strategy and planning providing clear direction

Both Thailand and Vietnam have clear examples of high level policy and strategies supporting application of NbS and more climate resilient communities. For example, Thailand's vision for national development is presented in the 12<sup>th</sup> National Economic and Social Development Plan (NESDP), which has been complemented by the 20-Year National Strategy which outlines a long-term vision for sustainable development and has been introduced to drive implementation of the 5 year NESDPs. The 12<sup>th</sup> NESDP focuses on reducing poverty and inequality, improving the competitiveness of the local economy including restructuring towards a digital economy, and green growth – including an increase of total forested areas to 40% and a net reduction in greenhouse gas emissions to 7%. Thailand 4.0 presents a new economic

model for the country and cuts across the 12th NESDP and 20-year strategy. The National Climate Adaptation Plan 2019 is built on the six priority sectors identified in the Climate Change Master Plan (2015–2050): water management, public health, human settlements and security, tourism, natural resources management, agriculture and food security.<sup>5</sup>

Vietnam has adopted a National Green Growth Strategy (VGGS) and developed a corresponding Green Growth Action Plan. One specific solution laid out in the VGGS is sustainable urbanization which includes commitments to:

- Develop and implement masterplans for rainwater drainage systems, urban waste and waste water collection, and transportation and treatment systems. In areas which are highly vulnerable to climate change, infrastructure should be adapted to climate change to minimize economic losses.
- Develop green cities, ecological urban areas and green works
- Green the urban landscape. Prioritize the allocation of public land to quickly expand the area of green coverage and water in urban areas, meeting the standards set for each city grade level. Stimulate investment and development of green space in urban projects and encourage communities, enterprises and households to mobilize resources to green urban landscapes.

In addition to enabling national policies and strategies, all four case studies provide examples of alignment of national, provincial and local policy, strategies and masterplans providing clear, high-level direction, for investment and growth. While the case studies undertaken by this project suggest that the high-level direction is clear, bringing the visions set in these policy documents to life will require action on a number of fronts including, regulatory reform, public-private collaboration and practical demonstration.

### Regulatory reform and pilot projects supporting action

A central objective of this project has been illustrating the value that can be added by NbS. However, practical application of some of the proposed technologies and approaches is currently constrained or prohibited by existing regulations and codes. In consultation with national experts across all the case studies, and particularly in Sukhumvit and Rayong, building regulations were cited as obstacles for implementing certain NbS. Examples include prohibition of private linkages to the main drainage system, and restrictions on altering road construction, which would limit the installation of green roofs, stormwater planter boxes, swales and depressed medians on primary roads. Planning codes were also identified as a limiting factor in the proposed private sector collaboration identified in the HCMC case.

The purpose of this project has been to illustrate what is possible and to build a case for reform where existing regulations are limiting potentially beneficial application of NbS. The case studies are an initial strategic assessment and show the value of further investigation. Well-designed pilot projects are a valuable way of providing the detailed evidence, local private sector capacity and stakeholder confidence needed for regulatory reform. Opportunities for public, private, academic and local stakeholder collaboration on pilot projects should also be explored. The case studies in the project have been selected to provide a good coverage of different contexts and NbS strategies and could form part of portfolio of small and large scale pilot projects.

### Value a broader set of options for a greater range of benefits

Each location is unique. The case studies have shown that considering a broader range of options and values creates opportunities for bespoke solutions that deliver more value. Wider application of the IUFM

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<sup>5</sup> UNDP. Development Finance Assessment Snapshot – Thailand. 2021. Available at: <https://www.th.undp.org/content/thailand/en/home/library/development-finance-assessment-snapshot---thailand-.html>

approach will add value to urban and investment planning by considering local, city wide and catchment scale issues, opportunities and objectives from a flooding as well as broader social, environmental and economic perspective. This broader perspective provides a basis for considering a wide range of retreat, adapt and defend flooding strategies that include both constructed, NbS and other structural solutions as well as non-structural solutions such as planning controls, community education, flood warning systems, disaster insurance etc.<sup>6</sup>

This broader perspective together with the flexibility and scalability of NbS have seen the cases studies include hybrid solutions that work with existing masterplans and infrastructure and respond to local context to add significant value to high density urban areas through:

- large NbS assets (parks) and smaller scale distributed assets (e.g. swales, tree pits, planter boxes, green roofs and walls) working together to form an integrated green precinct (e.g. Sukhumvit case study)
- networks of linear NbS assets integrated into urban roads and transport corridors, as well as retrofitting of grey areas such as car parks when large green spaces are limited (e.g. Rayong case study)
- a catchment-scale perspective identifying upstream action for downstream urban benefits and lower overall costs (see Phu Quoc, Sukhumvit and HCMC case studies)
- water cycle solutions for all four all cases studies including flood responses that also create water supply sources and decentralised solutions for sewage and drainage management that improve both water quality and quantity outcomes and support a longer term transition to separate drainage and sewage systems.
- circular economy outcomes enabling better management of solid and liquid waste (see Phu Quoc case study)

### More rigorous and transparent options comparison for better allocation of public resources

Once a broader range of options have been identified they need to be compared. The strategic assessments provided by the four case studies have used benefit–cost analysis (BCA) to develop quantitative estimates of the value of a NbS hybrid approach compared to a do nothing or conventional approach. Sensitivity testing has confirmed that even though data gaps have necessitated a number of high-level assumptions, the overarching conclusions remain.

BCA has been used because it is a proven and transparent approach for valuation and comparison of the costs and benefits. Better adoption of rigorous BCA analysis and integration NbS values into the budgeting processes and resources such as Thailand’s guidelines for Climate Change Budgeting Analysis (CCBA)<sup>7</sup> can inform more efficient and effective allocation of available public resources. Transparent exploration of project costs, risks, benefits and revenue streams will also aid financing.

While BCA has been used in this project, other methodologies are possible (e.g. multicriteria analysis, cost effective analysis) and no approach is perfect. A transparent and open process should be an essential part of applying any of these methodologies. The transparent and collaborative multiagency process used by the case studies in this project has helped ensure a good understanding of the local context, identify the best available data and testing the validity of key assumptions. It has also been critical to building the

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<sup>6</sup> For more information on the retreat adapt defend strategies see <https://openknowledge.worldbank.org/handle/10986/35710>

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[https://www.th.undp.org/content/thailand/en/home/library/environment\\_energy/climate\\_change\\_benefit\\_analysis\\_ccba\\_guidelines.html](https://www.th.undp.org/content/thailand/en/home/library/environment_energy/climate_change_benefit_analysis_ccba_guidelines.html)

shared understanding and commitment among stakeholders that is important for not only further progress on the case study sites but wider application of the approach.

The INFFEWS Value Tool<sup>8</sup> has enabled application of research from other Asian locations to inform an initial valuation of local benefits. Consideration could also be given to expanding the value tool data base, adding cost NbS benchmarks and undertaking local revealed or stated preference studies of key benefits within the case study locations. Further development of costs and benefits information would not only increase confidence in the proposed approach but also provide relevant local research to inform scaling hybrid approaches to other parts of Thailand, Vietnam and the greater Mekong region.

### Public, private and community collaboration to decrease costs and increase funding options

Public funding and financing will continue to play an important role in developing hybrid solutions but it is also clear that current public funding sources alone will not be sufficient to meet future needs. For example, in order to finance the VGGs, Vietnam needs to mobilize investment capital estimated to be at least \$30 billion.

The case studies undertaken as part of the project have provided examples of where NbS can assist in bridging the funding gap through reducing costs (e.g. lower construction and maintenance costs in the HCMC case study and reduced demand on the potable water supply in the Sukhumvit case), deferring investment (e.g. deferring combined sewer upgrades in Rayong) and unlocking new revenue streams (e.g. tourism and beneficial reuse of organic waste on Phu Quoc Island).

In addition to estimating the *total* benefits and costs, each case study has also provided information on the distribution of costs and benefits across locations, time and stakeholder groups. This can inform a better discussion around who should pay, their capacity to pay and how they should pay. In all case studies, NbS have provided both public and private good benefits. A number of examples are provided where public investment delivers significant benefits to a defined group of private citizens or commercial interests (e.g. increased flood protection leading to improved property local values or higher commercial returns) providing a case for targeted tariffs, taxes and/or transfers for realising those benefits.

An understanding of the distribution of benefits as part of a broader strategic engagement process has also been proposed as a means of helping to mobilise private investment. For example the roll out of small scale NbS such as raingardens, green roofs, tree pits or planter boxes in the Sukhumvit and Rayong case studies supported by targeted performance based incentives, (e.g. expansion of Floor Area Ration Bonus scheme in Thailand) or publicly funded education, citizen science, private sector capacity building, rebates and subsidies (as done by the 10,000 rain gardens initiative in Melbourne, Australia).

Targeted, performance-based support for the local development and application of NbS technology could also be provided through bodies such as the Thailand Board of Investment. Market based mechanisms such as including NbS in offset or abatement trading arrangements or introduction of tradeable stormwater rights have not been explored in detail in the case studies but are a potential extension of some of the funding and financing vehicles discussed. Application of market based mechanisms would require further information on local NbS performance characteristics, regulatory frameworks and institutional arrangements that should be further explored as part of future pilot projects.

The BCA analysis undertaken as part of the case studies also showed the importance of a whole of government and community perspective rather than just considering the costs and benefits to a lead

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<sup>8</sup> For more information see <https://watersensitivecities.org.au/investment-framework-for-economics-of-water-sensitive-cities-inffews-value-tool/>



organisation. The overall net benefits were positive in all cases but were much more marginal to the lead agency in three of the four case studies.

As well as greater inter-agency cooperation and activation of private and community groups to deliver hybrid solutions, more formal public private partnerships are also possible (such as to deliver the housing scheme proposed for Tam Phu Park). However, while promising innovation and access to private capital, formal engagement with the private sector collaboration should be informed by consideration of information and technical capacity asymmetries, clarity and measurability of objectives, risk allocation, current versus enabling governance and regulatory arrangements, transactions costs. Performance based public private partnership arrangements should also consider risk allocation and incentives for effective management of risks, costs and benefits throughout the project lifecycle.

### Seize opportunities offered by hybrid solutions for more inclusive development

Disadvantaged households often live in areas that are less safe, making them more exposed to flooding, pollutants and other hazards. A key finding of the case studies is the potential for NbS and hybrid solutions to promote inclusive development. For example, in HCMC and Phu Quoc, the solutions offer minimized social disruption from resettlement (and where necessary, resettlement in-situ), protecting against green gentrification and the exclusion of low-income residents who have strong community and livelihood ties to the area. The HCMC case study promotes a flagship 'eco-social' housing scheme. The concept designs also provide features that increase quality of life for local communities, including enhanced recreation and leisure opportunities and better health outcomes, including increased human thermal comfort, and decreased exposure to water-based pollution. The concepts would also provide additional livelihood opportunities and boost local economies. Accessible park design (paths, toilet facilities, signage, activities offered, plantings etc.) should also support gender balance and inclusion of people with cognitive, physical and sensory disabilities.

### Access a growing green finance market

The emerging green bond market has the potential to help mobilize financing for NbS within the urban context. For example, In May and October of 2018, the Urban Development Company (Chengtou, China) of Anji county in Zhejiang province issued two Sponge City Green Bonds of RMB 0.5 billion each, both with a 7-year tenor period, specifically for investments in constructing a sponge city demonstration zone in the eastern part of Anji county.

IUFM case studies prepared for China noted that compared with traditional credit mechanisms upon which Chinese sponge cities rely, green bonds have several advantages, including low yields, which can effectively reduce the cost of financing. They also lend themselves to promoting green industries because of their long bond cycles that allow for more effective management of the asset maturity mismatch of upstream banks. However, most green bonds are issued by banks, and the average tenor of issuances is still between three to five years, which may be too short for investments required to support NbS for IUFM. Lengthening the tenor of such bonds will require the entry of institutional investors such as pension funds and insurance companies. These kinds of institutional investors are typically not familiar with NbS for IUFM, so efforts are required to build their understanding of the costs, risks, benefits and performance of NbS investments relative to more conventional approaches. The methodology established in this project together with well designed pilot projects, enhanced regional collaboration and supporting guidelines and codes can be an effective means to achieve this understanding.