LEAPFROGGING PATHWAYS FOR A WATER SENSITIVE BOGOR

The Australia-Indonesia Centre

URBAN WATER RESEARCH CLUSTER

MONASH University

INSTITUT PERTANIAN BOGOR

UNIVERSITAS INDONESIA
Veritas, Probitas, Iustitia

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URBAN WATER CLUSTER PUBLICATIONS:

The key findings from this research collaboration have been published in a summary report titled "Leapfrogging Towards a Water Sensitive City: Exploring Pathways for Bogor" along with eight more detailed reports covering all deliverables. The full list of reports, including this one, is as follows:

"Leapfrogging Pathways for a Water Sensitive Bogor".

B Rogers, D Ramirez-Lovering, DR Marthanty, HS Arifin, M Farrelly, H Fowdar, A Gunn, J Holden, R L Kaswanto, R Marino, D McCarthy, W Novalia, E Payne, R Suwarso, Y Syaukat, C Urich, A Wright, D Yuliantoro.

"Benchmarking Bogor's Water Sensitive Performance"

B Rogers, C Brodnik, A Gunn, DR Marthanty, HS Arifin, D Ramirez-Lovering, M Farrelly, R L Kaswanto, N Pandjaitan, Y Suharnoto, R Suwarso, Y Syaukat.

"Governance for a Water Sensitive Transition in Greater Bogor"

M Farrelly, A Gunn, C Brodnik, J Holden, B Rogers, YA Setyono, R Suwarso, Y Syaukat, RA Velentina.

"Review of the application of green infrastructure for water management in Bogor"

E Payne, H Fowdar, D McCarthy, DR Marthanty, D Marsudiantoro, H Pawitan,

"Guidance on developing infrastructure adaptation scenarios for Bogor's water sensitive transition"

A Wright, C Urich, DR Marthanty, F Zulkarnain, Y Purwanto, N Mulyana Arifjaya,

"Pulo Geulis Revitalisation 2045: Urban Design and Implementation Roadmap"

D Ramirez-Lovering, R Marino Zamudio, HS Arifin, RL Kaswanto, HA Simarmata, D R Marthanty, C Brodnik, M Farrelly, H Fowler, A Gunn, J Holden, L Maryonoputri, N Panjaitan, E Payne, B Rogers, Y Syaukat, Y Suharnoto, R Suwarso, I Sondang, C Urich, A Wright, , D Yuliantoro

"Griya Katulampa: Lessons Learned Case Study Report"

D Ramirez-Lovering, R Marino Zamudio, HS Arifin, RL Kaswanto, HA Simarmata, DR Marthanty, C Brodnik, M Farrelly, H Fowler, A Gunn, J Holden, L Maryonoputri, N Panjaitan, E Payne, B Rogers, Y Syaukat, Y Suharnoto, R Suwarso, I Sondang, C Urich, A Wright, D Yuliantoro,

"Situ Front City: Transition Strategy to WSC"

D Ramirez-Lovering, R Marino Zamudio, HS Arifin, RL Kaswanto, HA Simarmata, DR Marthanty, C Brodnik, M Farrelly, H Fowler, A Gunn, J Holden, L Maryonoputri, N Panjaitan, E Payne, B Rogers, Y Syaukat, Y Suharnoto, R Suwarso, I Sondang, C Urich, A Wright, D Yuliantoro

"Sentul City: Lessons Learned Case Study Report"

D Ramirez-Lovering, R Marino Zamudio, HS Arifin, RL Kaswanto, HA Simarmata, DR Marthanty, C Brodnik, M Farrelly, H Fowler, A Gunn, J Holden, L Maryonoputri, N Panjaitan, E Payne, B Rogers, Y Syaukat, Y Suharnoto, R Suwarso, I Sondang, C Urich, A Wright, D Yuliantoro

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GLOSSARY

Bappeda	*Badan Perencanaan Pembangunan Daerah*, Regional Development Planning Board
Bappenas	*Badan Perencanaan Pembangunan Nasional*, National Development Planning Agency
FGD	Focus group discussion
IPB	*Institut Pertanian Bogor*, Bogor Agricultural University
IWM	Integrated water management
Kabupaten	Regency Government
Kampung	Literally 'village', but in urban contexts means slum or informal settlement
Kecamatan	District
Kelurahan	Subdistrict
Kota	City Government
MU	Monash University
Musrenbang	*Musyawarah Perencanaan Pembangunan,* Development Planning Consultation
PAL	*Pengelolaan Air Limbah, Wastewater Utility*
PDAM	*Perusahaan Daerah Air Minum*, Drinking Water Supply Company
RPJMD	*Rencana Pembangunan Jangka Menengah Daera*h, Medium term local government strategy
RPJMN	*Rencana Pembangunan Jangka Menengah Nasional,* National Medium Term Development Plan
Situ	A natural or artificial lake
SPAL	*Saluran Penyaluran Air Limbah,* Wastewater Network
UI	*Universitas Indonesia*, University of Indonesia
UWC	Urban Water Cluster
WSC	Water sensitive city

EXECUTIVE SUMMARY

INTRODUCTION

Greater Bogor, like most other Indonesian cities, is experiencing rapid growth accompanied by pressure on essential services. In recent years, Bogor has demonstrated environmental commitment by pursuing green agendas, and now has embraced a vision of a transition towards holistic and sustainable approaches to urban water management.

The Australia-Indonesia Centre Urban Water Cluster research project has applied a water sensitive city (WSC) framework to Bogor to substantiate and facilitate its sustainable water aspirations. The WSC approach embraces cross-cutting and holistic solutions that deliver multiple benefits. This is expected to provide a strong foundation for tackling the multidimensional challenges required of Indonesia's commitment to the Sustainable Development Goals (SDGs).

The WSC approach is underpinned by three pillars of practice: (i) cities as water supply catchments; (ii) cities providing ecosystem services; and (iii) cities comprising water sensitive communities. The approach envisages centralised and piped water systems to be complemented by more distributed, modular, and green infrastructures that deliver multiple functions and benefits, from safe water supply, sanitation services, water quality treatment, flood protection, urban heat mitigation, to community wellbeing and participation.

Achieving a WSC approach requires change in key spheres of operation, such as system design and planning, professional practice and technological solutions, and community behaviour. Transformation requires a combination of technical innovation and social and institutional restructuring to overcome entrenched unsustainability. Indonesia's transition to a WSC may need to make greater advances in productivity, resilience and liveability than industrialised economies, but it may also have the opportunity to leapfrog some unsustainable patterns of production and growth associated with economies that industrialised earlier.

Leapfrogging is a phenomenon in which developing countries—whose technological systems are not yet as fully-established as developed economies—can adopt advanced technological systems to address current environmental issues. This report assesses Bogor's capacity for a WSC transition and recommends enabling strategies using the lens of leapfrogging. By doing so, it is hoped that Bogor and other Indonesian cities may avoid features of water servicing models seen in developed economies that represent unsustainable 'dead ends', and adopt more holistic and sustainable water technologies and management approaches that are based on WSC principles.

This research takes advantage of new socio-technical tools and methods to assess Indonesian WSC leapfrogging potential through in-depth case study research in Bogor, develop insights and practical recommendations for Bogor's leapfrogging journey, and derive general insights and recommendations for WSC leapfrogging in other Indonesian cities. Specific objectives of the research include:

- Applying a benchmarking framework for assessing the water sensitivity (in particular the liveability, sustainability and resilience) of Bogor and identifying opportunities for enabling water sensitive approaches
- Identifying social and institutional structures and processes that create enabling conditions for Bogor to advance its water sensitive transition
- Developing broad adaptation pathways to ensure the provision of equitable, affordable and safe urban water services over the long-term against different climatic, urbanisation and societal challenges
- Evaluating the general suitability of available low-energy and low-cost stormwater harvesting and water treatment systems for Bogor
- Guiding water-sensitive urban design through a range of design and demonstration activities in case study locations that represent different development typologies
- Developing active WSC learning alliances with stakeholders from universities, government, industry, business and community.

Bogor was selected for research as it is a subregion of Greater Jakarta (*Jabodetabek*), therefore having significance to the broader water system of *Jabodetabek* and related planning drivers, but also having a more manageable scale and complexity.

ISSUES

This strategy aims to respond to a number of systemic challenges faced by Bogor and many other cities in Indonesia.

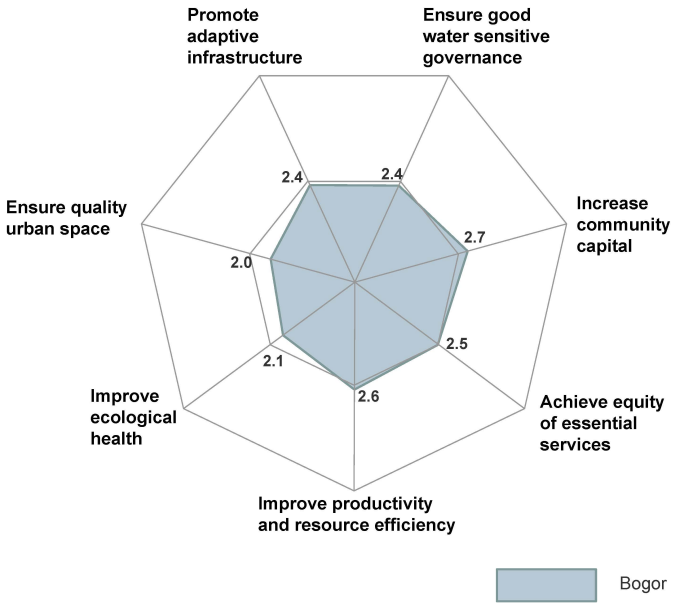
Systemic challenges faced by Bogor

Long-term water supply planning responding to urban population and climate drivers	• Risk of unsustainable groundwater abstraction • Risk of wastewater contamination of groundwater supplies • Potable network reliability, administrative losses and maintenance shortfalls • Climate change adaptation planning capability • Need for integrated supply & demand strategy across separate water supply agencies (PDAM) and networks
Limited resources for implementing sustainable solutions	• Limited funding for long-term local priorities • Prevailing urban development pattern not suited to sustainable retrofit – existing open space highly contested
Degradation of water bodies	• Encroachment on riparian buffer zones by settlement • Degradation of riparian vegetation • Little treatment of stormwater and greywater before entering drainage system • Discharge of untreated blackwater into water bodies
Excess stormwater runoff and flooding	• Flooding in Bogor in the wet season, but with potential for more significant downstream impacts • Little implementation of onsite retention

	• Drainage network's lack of effectiveness for its primary purpose, poor integration, and lack of asset records
Community attitudes to ecosystem services	• Interest in water sensitive practices low • Prevalence of litter in waterways • Household maintenance of wastewater generally insufficient • Community environmental and water cycle knowledge weak
Limited local expertise to enable WSC outcomes	• Need for capacity-building in government agencies in key enabling systems and practices • Policy preference for structural solutions • Regulatory policy not aligned with integrated water management objectives • Need for capacity to delivery non-structural approaches • Collaborative governance and community engagement practices need to be broader in scope

CURRENT WATER SENSITIVE PERFORMANCE

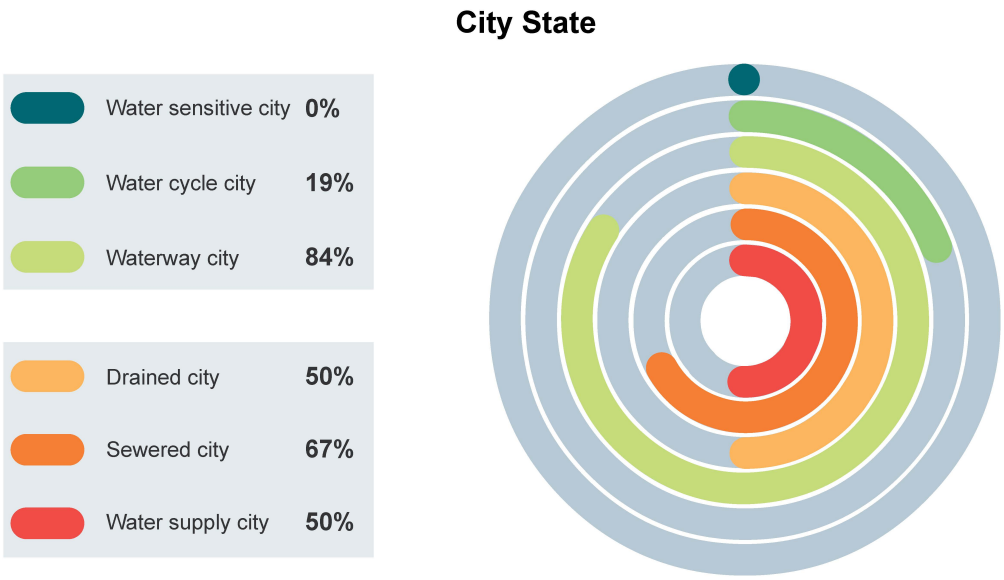
The Water Sensitive Cities (WSC) Index, developed by the Cooperative Research Centre for Water Sensitive Cities, provides systemic, integrated urban water benchmarking.



Summary of the results of Greater Bogor's benchmarking with the WSC Index across the seven goals

The seven WSC Index goal scores are relatively even, with average scores in the range of 2.0-2.7 out of 5. The highest score, by a small margin, was given to *Increase community capital* for the community's firm connections with water, participation in the water management system through operation of wells, bores and septic tanks, and moderate levels of disaster preparedness.

The indicators of the WSC Index are mapped to six states of water system performance, adapted from the Urban Water Transitions Framework (UWTF) (Brown et al., 2009). Cities achieve certain performance markers associated with the priorities of the six developmental states of the UWTF as they journey towards a water sensitive city. This transition journey is not necessarily linear, as a city may show indicators of later developmental states (with 19% attainment in water cycle city, for example) while not fully satisfying earlier states (with *Water supply city* scoring 50%, *Sewered city* scoring 67%, and *Drained city* showing 50% attainment).



Summary of the benchmarking results for Greater Bogor analysed and measured against progress represented by the city-states

LEAPFROGGING PATHWAYS

The Urban Water Cluster has assessed Greater Bogor's current water system through the WSC framework and identified strategies to expedite its WSC transition through leapfrogging. The strategies are broad in scope and designed to address key water issues identified through the research and enable change towards water sensitive outcomes over the short- and long-term.

The recommended strategies are organised into six leapfrogging pathways. The pathways are intended to be considered for investment as a whole, as the underlying strategies are often inter-related and mutually reinforce achievement of Greater Bogor's water sensitive aspirations. Each strategy is associated with a likely time horizon for it to be feasibly implemented: short-term (0-3 years), medium-term (3-10 years) and long-term (10 years onwards).

The recommended short-term strategies provide guidance on initiatives to progress as a priority in the coming years to rapidly advance Greater Bogor's water sensitive city leapfrogging journey.

It is recommended that the momentum of this Urban Water Cluster research be built upon to immediately establish a governance framework for implementing this WSC leapfrogging strategy (1.1). This framework would become a key driver of collaboration within and across organisations (3.2), underpinned by a strategic water sensitive city vision for Greater Bogor collectively developed by diverse government, industry, community and research stakeholders (1.2). The framework would also support the WSC Learning Alliance (6.1) established as part of this research to build capacity to adopt water sensitive practices amongst Bogor's water and urban professionals.

Priorities for on-ground action include learning from previous experiences as well as creating opportunities for new learning from laboratory testing and field demonstrations (5.1-5.3). Greater understanding of data requirements for optimal water system planning (6.2) and of the barriers for households to adopt water sensitive practices (4.1) will improve the effectiveness of policy implementation at different scales. Processes for inclusive and participatory strategic planning (3.3) and meaningful community engagement (4.2) are also important foundations of sustained support for the water sensitive agenda in Greater Bogor.

Pathway 1: Commit to Greater Bogor's water sensitive future

1.1 Establish a governance framework for implementing the leapfrogging strategy

Immediate establishment of a working party to review and discuss in more detail the outcomes and recommendations of WSC research would help to codevelop a forward plan for addressing key priorities. From there, ongoing coordination and support from key agencies is needed to shape the innovative and adaptive strategic water management approaches promoted in this WSC leapfrogging strategy. A governance framework that addresses collective roles and responsibilities, shared learning needs, leadership capacity-building, and other directions for implementing key enablers of the water sensitive transition will be useful to drive and guide collective strategic action.

1.2 Collaboratively develop a strategic water sensitive city vision

A strategic vision for Greater Bogor, founded on water sensitive principles and building on pride in the city's existing attributes, will help build broad political and policy support for transforming practices and urban spaces to become water sensitive. Visioning processes are powerful when they engage with diverse stakeholders, have a cross-sectoral focus and capture the values and priorities expressed by the community.

1.3 Create and align government strategies and plans with the vision

Embedding Greater Bogor's strategic water sensitive city vision in government strategies and plans will help to institutionalise the commitment and clarify responsibilities for delivering the vision. Translating the vision into formal planning processes can also help coordinate resource allocation to support implementation.

1.4 Monitor progress towards the water sensitive city vision

The WSC Index is a useful tool for structuring evidence of the current performance of Greater Bogor with respect to a wide range of WSC aspirations and diagnosing the

pressing needs and priorities to inform policy and strategy. Periodic assessment with the WSC Index may be useful for accumulating system information and tracking progress towards Greater Bogor's water sensitive leapfrogging goals.

Pathway 2: Improve regulatory performance for water sensitive outcomes

2.1 Evaluate the impact of water, environment and land use planning regulations

Overcoming challenges to implement regulations will ultimately need to involve aligned action by all levels of government. Local government can take steps in the short-term to develop its regulatory practice by evaluating the performance of current regulation in meeting the intended outcomes, and its potential for enabling and driving the aspired water sensitive outcomes.

2.2 Develop standards and targets based on the water sensitive city vision and objectives

Water system and land use standards and targets that reflect Bogor's WSC priorities, accompanied by technical guidance for their achievement, will help drive implementation. Standards and targets are best established through negotiated processes that capture community values and reflect local system data. However, in the short-term there may be value in reviewing those in use in other similar jurisdictions to determine their potential suitability for interim use in Greater Bogor.

2.3 Protect and leverage existing ecological and infrastructure assets as a foundation for green infrastructure

Existing ecological assets in Greater Bogor can provide an important base for expanding and enhancing green infrastructure in the city. This includes preventing loss and degradation of areas of ecological value, such as situs and green space, through stronger land use regulations and commitment to enforcement. In addition, existing infrastructure such as drainage channels has the potential to be repurposed or reconfigured to deliver broader benefits, including flood mitigation, water treatment, ecological functioning, and urban liveability.

Pathway 3: Support integration and coordination across water and urban stakeholders

3.1 Facilitate collaboration within and across organisations

Platforms that bring together government agencies, non-government organisations, academia and the community to collaborate will help to drive coherent city-wide action. Such platforms could include policy forums that can promote reform in the mono-disciplinary cultures of agencies to introduce innovations and multi-agency project teams that break down barriers between organisations. Professionals with specialist skills and an ability to cross organisational and disciplinary boundaries can be valuable team members in infrastructure and planning units.

3.2 Conduct inclusive, participatory strategic planning processes

An inclusive approach to setting the long-term water sensitive vision and leapfrogging objectives will be important. Dedicated resources are needed to identify and target important stakeholders, develop attractive messages to encourage

effective engagement, and to facilitate forums for capturing useful feedback for strategic planning purposes.

3.3 Develop platforms for sharing data

Mechanisms for sharing data and information are crucial to achieve coordinated planning and infrastructure development. New systems and policies can enable data to be accessed and analysed by users across organisations to create integrated outcomes in system planning. This would need investment in systems for standardising data quality control procedures and data management across Greater Bogor, and the development of accessible platforms for sharing data and analysis.

3.4 Advocate for more coherent urban water resource management

Institutional reforms to achieve more effective water system management need careful consideration and direction from central and provincial government. Local government can help to build the case for reform by collecting and reporting supporting evidence, engaging with the community about water management and bringing issues and opportunities to high-level forums.

3.5 Coordinate urban planning and the provision of water infrastructure

Local, provincial and central government agencies have a role to play in the planning and implementation of water sensitive solutions. Urban planners and landscape architects should engage with those involved in water sensitive solution design at the outset of development planning to make the best use of available assets and to create multi-functional systems.

3.6 Strengthen integrated catchment management in land use planning

Efforts to strengthen catchment-based strategic planning would enable settlement planning to achieve integrated outcomes agreed to by all urban and water stakeholders. Outcomes may include protecting flood prone areas from inappropriate development, consistent measures to reduce stormwater flows from impervious surfaces, coordinated planning for effective solid waste management, and efficient funding of flood management works.

Pathway 4: Empower communities to become water sensitive

4.1 Understand barriers to the adoption of household water sensitive practices

To increase the impact of community interventions, it is important to better understand the barriers to adoption of water sensitive practices such as rainwater capture or effective waste disposal. Information gained from community social research can be used to design more effective strategies to enlist the community to undertake desired behaviours.

4.2 Implement meaningful community engagement processes for water projects

Consistent and open consultation practices early in the planning and design process would help support community participation in water planning. Effective approaches embrace the social and commercial use of public space by providing integrated solutions that can accommodate the current activities while providing ecological services and amenity for users.

4.3 Develop skills in citizens to adopt water sensitive practices

Several critical knowledge and skills gaps will need to be addressed to support citizens to implement water sensitive solutions. These include what citizens should do before, during and after floods, how to increase the productivity of local urban farming, water-related small business and other sustainability activities, and how to sustainably adapt to climate change.

4.4 Support greening of the private realm

Water sensitive greening of the private realm is critical for Bogor to achieve its vegetation cover target and other local water sensitive aspirations. A range of linked socialisation and behavioural change strategies are recommended alongside planning controls. These could include information sessions, competitions for greening kampungs, programmes to support local residents' urban greening groups, whole-of-city mobilisation behind a 'Green Bogor', and technical support from international non-government organisations (NGOs) and development assistance agencies.

Pathway 5: Develop local evidence and experience from water sensitive approaches

5.1 Introduce initiatives to facilitate learning from project experiences

It is important to capture detailed documentation of (previous and current) projects at key stages of development and host databases and case studies in central repositories that are widely accessible to decision-makers, practitioners and researchers. It is also important to promote learning from specific projects in place, for example through use of signage and site tours to explain water sensitive projects.

5.2 Coordinate green infrastructure testing under laboratory and local field conditions

Green infrastructure needs to be tested under a variety of conditions to enable designs to be adapted to best suit local conditions and to develop an understanding of appropriate local construction, operation and maintenance procedures and costs. Such work is key to providing a foundation for local adoption guidelines for green infrastructure. Although several organisations in Bogor already undertake testing, its significance needs to be bolstered and its coordination would realise more strategic contributions to practice.

5.3 Develop technology demonstrations and proofs of concept

Demonstration projects that provide on-ground examples of an innovative water sensitive solution are critical for local proof-of-concept and as a learning opportunity for stakeholders. It is important to capture all potential lessons from demonstrations, including social, technical and economic evidence and insights, through detailed documentation and dissemination.

5.4 Collect evidence of the multiple benefits achieved by water sensitive systems

Information that quantifies the multiple benefits of water sensitive systems or improves understanding of system costs is important to collect. It may be useful to build partnerships with the community sector, academia or international organisations to apply evaluation techniques that capture social, environmental and economic benefits.

5.5 Develop locally-specific business cases for water sensitive approaches

Example business cases for multi-functional water sensitive infrastructure for the local Bogor conditions will be important to show why diverse stakeholders benefit from and should contribute towards initiatives such as rainwater harvesting or stormwater runoff diversion and treatment in parks and public open space.

5.6 Develop and implement plans for scaling and replication

Demonstration projects can create significant momentum amongst stakeholders and potential investors. It is important to develop and implement plans to harness this momentum for scaling and replication of water sensitive projects across Bogor. Dedicated resources to review lessons from demonstration projects will help inform plans to do this efficiently and effectively.

Pathway 6: Build professional capacity for water sensitive practices

6.1 Formalise and support the WSC Learning Alliance for Bogor's water and urban professionals

Leapfrogging to a water sensitive city will involve the adoption of new practices and diffusion of water innovations. Professionals involved in these changes, across government, industry and academia, need the opportunity to learn together to build collective knowledge and experience. Agency leadership is important for formalising the Learning Alliance and facilitating networks that can cut through silos both within and between organisations. Individual water sensitive city champions are important participants in the Learning Alliance to build momentum and influence. Local and international universities, and other research centres with expertise in water sensitive approaches, would be valuable for the Learning Alliance to engage and partner with.

6.2 Understand data requirements for water system planning

A framework for prioritising investment in data collection and analysis should be developed to inform long-term data resourcing decisions. A data management framework would describe the data requirements for integrated water system planning, identify foundational datasets that are critical in the short-term, and define the degree of aggregation suitable for effective decision-making.

6.3 Develop guidance and training for planning and designing water sensitive solutions

While comprehensive guidance based on local evidence is desirable over the long-term, initial steps could focus on assessing the suitability of existing guidance from other jurisdictions and making adaptations for local use. Technical advice from universities and international agencies may be useful to inform planning and design guidance. Relevant agencies may find it useful to promote general training and capacity building in the application of existing planning and design tools.

6.4 Develop professional skills for implementing social and economic solutions

Improving the capacity to deliver social and economic interventions can create new pathways for delivering water sensitive outcomes. Such solutions could include incentive schemes, regulation, participatory processes and community engagement campaigns. Building public sector skills and capacity to evaluate the full range of

implementation options may reveal the most cost-effective means of achieving water sensitive policy objectives. A particular focus on skills to engage in multi-disciplinary programs and innovative multi-stakeholder water projects is important for Bogor.

6.5 Develop decision-support tools that overcome lack of data availability and reliability

For Bogor, it is useful to understand deficiencies in data quality to reinforce advocacy for improvements. In the meantime, it may be useful to develop robust tools that consolidate and integrate different sources of data, including contextual knowledge as well as new data capturing techniques (e.g. drone surveys), to support planning and decision-making until more comprehensive data can be established.

6.6 Build maintenance needs into water sensitive project planning and design

Improved water infrastructure maintenance is a pressing need for Greater Bogor's existing drainage, sewerage and water supply systems. This will continue to be important as green infrastructure is deployed as part of Greater Bogor's transition to a water sensitive city. Maintenance needs should be incorporated during project planning and design. Key considerations are the degree of sophistication of the system, the scale of its operation and the likely responsible stakeholder and budget allocation for implementing the maintenance regime.

APPLICATION OF LEAPFROGGING STRATEGIES TO DEVELOPMENT TYPOLOGIES

Leapfrogging strategies were considered for application to different development contexts based on UWC case study sites. This was intended to illustrate the suitability of the strategies to different urban environments and development needs.

Development typology derived from project case studies

Development scenario	*Kampung* regeneration	Small-scale consolidation	Precinct-scale mixed use renewal	Greenfield urban expansion
Density	High	Medium	Medium-High	Low-High
Timescale for development	Medium	Long	Short	Medium
Case study	Pulo Geulis, Bogor City	Griya Katulampa, Bogor City	Situ Front City, Bogor Regency	Sentul City, Bogor Regency

The development typology informed by the case studies (described in the table above) involves four broad types: (1) urban regeneration, particularly in the context of high density slums and informal settlements; (2) small-scale urban consolidation and incremental upgrade of low and medium density housing; (3) precinct-scale mixed-use redevelopment of greenfield, greyfield, and brownfield sites; and (4) expansion at existing urban boundaries using predominantly greenfield sites and at low-to-high population densities.

The outcomes of this analysis show a small degree of reprioritisation of strategies for different development contexts. This can inform government decision-making when faced with dominant development contexts or equity considerations.

Chapter 1

Introduction

1. INTRODUCTION

1.1. BACKGROUND

By 2050 about 90 per cent of global growth in urban inhabitants is projected to populate developing cities, especially in Asian and African regions (UNDESA, 2014). The burgeoning urban population will place tremendous pressure on cities' capacities to deliver sustainable urban water solutions. Although the Millennium Development Goals (MDGs) have pushed for greater water and sanitation service coverage in many parts of the developing worlds, the remaining gap will magnify in the future as urban population continues to grow.

Like most cities in the global South, Indonesian cities are experiencing rapid growth accompanied by pressure on essential services. Indonesia is the fourth most populous country in the world, and in 2011, the urban population exceeded the rural population for the first time and the gap has grown steadily since (World Bank, 2018). By 2035, the urban population of West Java is expected to exceed 80% (Bappenas, 2013, cited in Hudalah, Rahmat & Firman, 2016).

Triggered by continuing urbanization, water systems in Indonesia are under severe strain, with increased water consumption and pollution impacting on both surface water and groundwater resources. This has serious and long-term implications for water security and health. Taking Indonesia's most urbanised island, Java, as an example, 53% of households, or about 21 million, depend on local, untreated groundwater for drinking water (BPS Indonesia, 2018). Continued land use change has also increased the severity and frequency of extreme flooding events; the impacts of flooding in Java was estimated in 2011 to affect 10% of the population, or 13 million people (Asian Development Bank, 2016).

Indonesia's commitment to the Sustainable Development Goals (SDGs) sets a framework for addressing these complex and interlinked challenges. Cross-cutting solutions that can deliver multiple benefits such as access to safe water supply and sanitation, reduced environmental pollution, and community empowerment are built into the SDGs (Le Blanc, 2015). It is important to broaden the currently narrow focus on delivering traditional urban water approaches—based on centralised and piped infrastructure systems—towards more sustainable approaches that can tackle multidimensional challenges.

One of the leading alternative urban water management approaches is known as the Water Sensitive City (WSC) approach (Wong & Brown, 2009). This approach is based on a holistic view of urban water systems underpinned by three pillars of practice: (i) cities as water supply catchments; (ii) cities providing ecosystem services; and (iii) cities comprising water sensitive communities. The approach envisages centralised and piped water systems to be complemented by more distributed, modular, and green infrastructures that deliver multiple functions and benefits, from safe water supply, sanitation services, water quality treatment, flood protection, urban heat mitigation, to community wellbeing and participation.

Identifying opportunities for adopting and implementing the WSC approach in Indonesian cities can therefore facilitate the realisation of the SDGs.

A key opportunity is the relatively limited coverage of conventional water infrastructure systems in most Indonesian cities, which represents an opportunity for 'leapfrogging' towards more advanced technological systems and more sustainable approaches. Within sustainability literature, leapfrogging is a phenomenon in which developing countries—whose technological systems are not yet as fully-established as developed countries—can avoid historical development pathways and stages by adopting the latest and most advanced technological systems to address current environmental issues (Perkins, 2003). Scholars argue that there is a significant potential for emerging economies to skip the conventional pathways and associated negative environmental consequences formerly adopted by established economies that had prioritised economic growth above sustainable development (Binz & Truffer, 2009; Perkins, 2003).

The application of the leapfrogging concept in the study of urban water systems points to the possibility of accelerating wider adoption of more sustainable urban water management approaches in developing cities. As characterised by Brown et al. (2009) cities in developed economies have typically gone through linear stages of service delivery functions from water supply, sewerage installation, drainage management and waterway management, and are in the midst of transitioning to whole-of-water cycle management before arriving at a water sensitive city (see Figure 1). Leapfrogging argues for the potential of emerging economies to adopt water sensitive approaches without intermediate transition stages. Through the leapfrogging lens, this report will assess the current conditions and capacity for Bogor to shift towards wide adoption of more holistic and sustainable water technologies and management approaches that are based on the WSC principles.

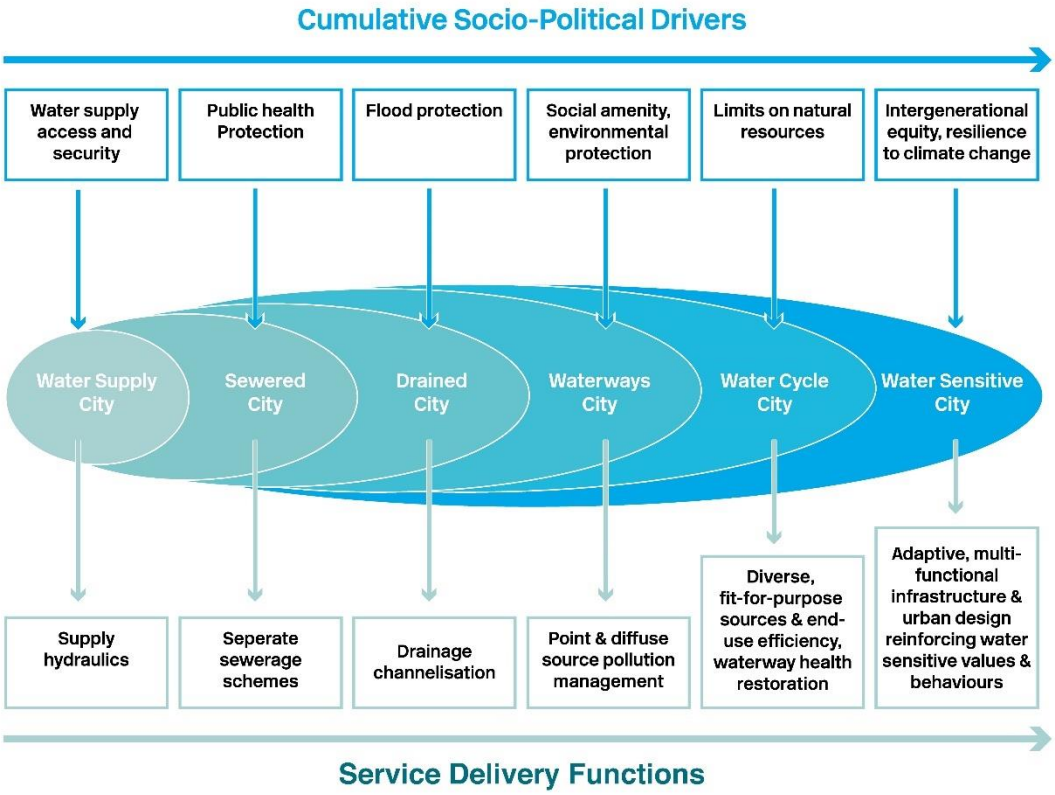


Figure 1. Urban water transitions framework (Brown et al., 2009)

The case study site used for this exploration of leapfrogging to a water sensitive city is Bogor, on the island of Java, located about 75 km south of the capital, Jakarta. Bogor's reputation as the 'city of rain' and 'city in the garden', suggests it is ideal for transformation to a water sensitive city. The strategy outlined in this report also reflects regional governments' agenda to build upon this foundation to become a green city of the future. It has been accompanied by commitments from key departments and elected officials from municipalities in the study area.

1.2. RESEARCH AIMS AND OBJECTIVES

Ensuring the liveability, sustainability and resilience of a city and its water system requires a complex mix of technological, planning, economic, cultural and institutional dimensions to be considered in developing leapfrogging strategies and investment plans. The question of how to transition towards water sensitivity is relevant for individual utilities, governments, universities, private entities and donor organisations that inhabit the larger socio-political system. Such transformative change processes are not easy. Contemporary research makes clear that a focus on technical innovation, though important, is not enough, and that understanding the social and institutional dynamics that underlie any city's transition attempt is key when trying to shift entrenched water management systems towards sustainability.

This research takes advantage of new socio-technical tools and methods to assess Indonesian WSC leapfrogging potential through in-depth case study research in

Bogor, develop insights and practical recommendations for Bogor's leapfrogging journey, and derive general insights for WSC leapfrogging in other Indonesian cities. Specific objectives of the research include:

- Applying a benchmarking framework for assessing the water sensitivity (in particular the liveability, sustainability and resilience) of Bogor and identifying management actions that take advantage of leapfrogging opportunities
- Identifying social and institutional structures and processes that create enabling conditions for Bogor to advance its water sensitive transition
- Developing broad adaptation pathways to ensure the provision of equitable, affordable and safe urban water services over the long-term against different climatic, urbanisation and societal challenges
- Evaluating the general suitability of available low-energy and low-cost stormwater harvesting and water treatment systems for Bogor and similar Indonesian cities
- Guiding water-sensitive urban design through a range of design and demonstration activities in case study locations that represent different development typologies
- Developing active WSC learning alliances with stakeholders from universities, government, industry, business and community.

1.3. RESEARCH APPROACH

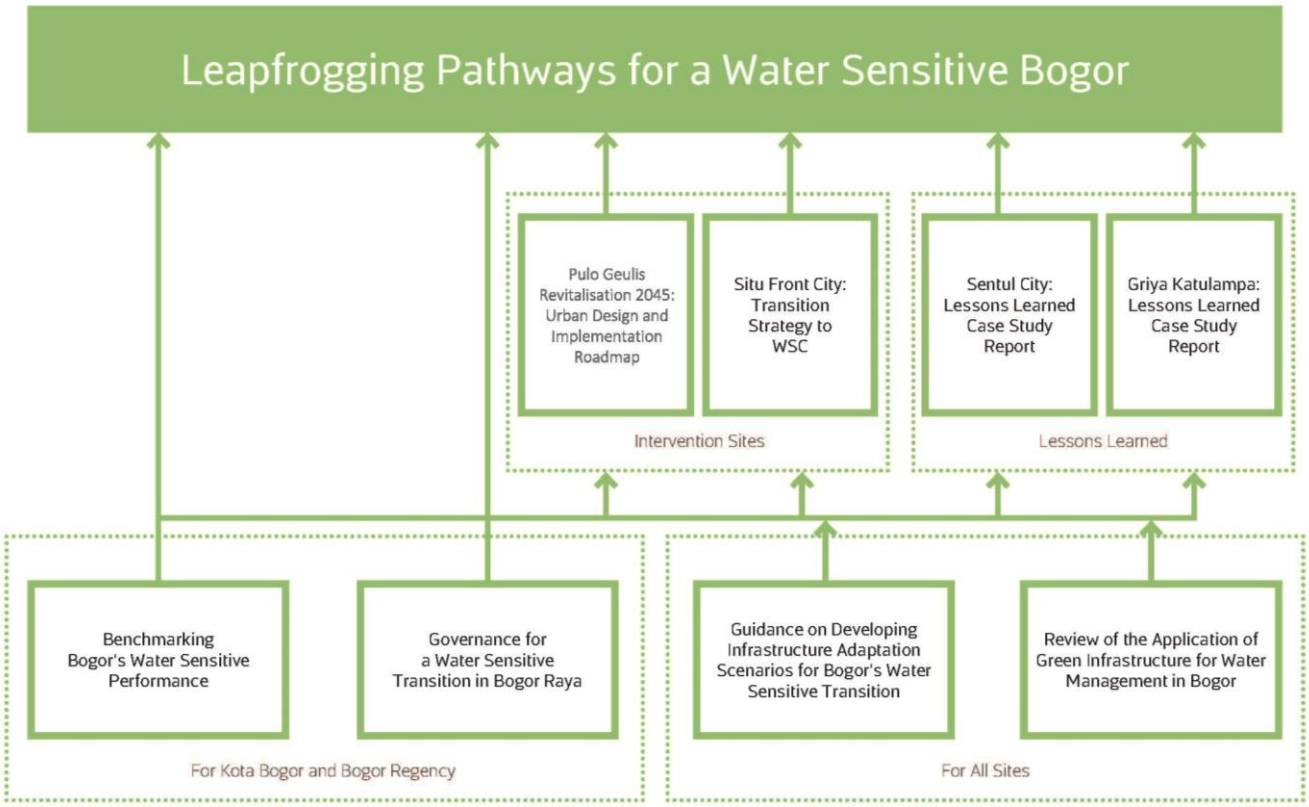
Bogor was selected for research as it is a subregion of Greater Jakarta (*Jabodetabek*), therefore having significance to the broader water system of *Jabodetabek* and related planning drivers, but also having a more manageable scale and complexity.

The research underpinning this report took place in 2017 and 2018. It is founded on a collaborative research methodology with projects co-led by Indonesian and Australian researchers. The research was based on a multi-disciplinary set of investigations that involved governance and politics, green infrastructure, urban design and hydrological modelling producing separate outputs, as well as interdisciplinary collaboration to propose integrated strategic recommendations. A key interdisciplinary output was system benchmarking using the WSC Index (refer to the accompanying report, ***Benchmarking Bogor's Water Sensitive Performance***). This benchmarking was conducted across multiple engagements between November 2017 and August 2018 in consultation with approximately 20 experts in disciplines and practices relevant to the indicators.

Field work for this research took several forms: unstructured individual and focus group interviews that took place between November 2017 and July 2018; design charettes; long-term vision co-development; water sampling, and hydrological modelling. Field work was organised around four case sites that reflect prominent urban development archetypes in Indonesia. Each case study site was selected based on their spatial/social/economic conditions to provide a comprehensive range of the different ways in which cities develop and transform over time, especially in developing countries. The case study sites varied in scale (small area with high

population density to large area with low population density), land tenure (i.e., informal or formal), resident socio-economic status, and administrative region (i.e., Bogor City or Bogor Regency.

In addition to field work, an extensive review of relevant governance and water planning literature for Indonesia was undertaken, as well as an enquiry into relevant strategies, plans and statistical publications published by governments with jurisdiction over Greater Bogor. The AIC UWC Reports structure is as follows:



The companion reports associated with the UWC research program are:

- *Benchmarking Bogor's Water Sensitive Performance*
- *Governance for a Water Sensitive Transition in Greater Bogor*
- *Review of the application of green infrastructure for water management in Bogor*
- *Guidance on developing infrastructure adaptation scenarios for Bogor's water sensitive transition*
- *Pulo Geulis Revitalisation 2045: Urban Design and Implementation Roadmap*
- *Griya Katulampa: Lessons Learned Case Study Report*
- *Situ Front City: Transition Strategy to WSC*
- *Sentul City: Lessons Learned Case Study Report*

1.4. THIS REPORT

The purpose of this report is to present key messages from this research collaboration to guide and structure cross-sectoral implementation activities over the short, medium and long-term. As such, it is primarily aimed as a resource for Bogor

industry stakeholders, including government spatial, social and water system planners, local researchers and the private sector water industry. It should also be of interest to governance and adaptation academics with an interest in water sensitive city transitions in a developing context.

Following this introduction, the remainder of the report is set out in 4 sections. The first of these sections (Section 2) provides an overview of the water system in Bogor from socio-political and biophysical perspectives, and the dominant drivers and challenges relevant to water system planning. Key insights from benchmarking analysis of the water sensitive based on the Water Sensitive Cities (WSC) Index are discussed here. Following the analysis of current system performance, there is a brief section exploring a potential water sensitive future for Bogor derived from the seven goals adopted for the WSC Index.

Section 4 presents strategic recommendations informed by the research activities of the project in disciplines as diverse as governance, architecture, urban design, spatial planning, hydrological modelling and engineering. The strategies are informed by international research into enablers of WSC transitions and technological leapfrogging of developing systems. The strategies are also framed by a recommended implementation timeline of short (0-3 years), medium (3-10 years) and long (more than 10 years) term.

In recognition that the study area has a heterogeneous enabling environment, Section 5 explores the roll-out of leapfrogging strategies for four development scenarios for which the case study sites are representative. Key differences in the development scenarios suggest the need to vary the priority for some leapfrogging strategies, for example the unique conditions characterising *kampung* or urban slum area regeneration favour initiatives associated with collaboration, technological innovation, participation and engagement over those related to regulatory performance.

The concluding Section 6 summarises the key messages from the strategies and assesses the insights from this project in terms of the goal of achieving leapfrogging in other Indonesian cities. It concludes with recommendations for further research.

Chapter 2

Understanding Bogor's current water system

2. UNDERSTANDING BOGOR'S CURRENT WATER SYSTEM

2.1. REGIONAL AND NATIONAL WATER SYSTEM DRIVERS

Bogor city and region are part of the national strategic region known as *Jabodetabekpunjur*, which is an acronym of seven major metropolitan areas (Jakarta, Bogor, Depok, Tangerang, Bekasi, Puncak and Cianjur) that are administratively organised across three provinces, DKI Jakarta, Western Java, and Banten. The region is strategic in socio-political and biophysical terms, contributing to a quarter of national Gross Domestic Product (BPS Indonesia, 2018). The important economic role and significant population growth in the metropolitan region have, in turn, raised concerns over interregional alignment of activities, spatial connectivity of key resource systems, and mitigation of negative impacts on the environment.

For some years, a key focus of planning in *Jabodetabekpunjur* has been promoting integrated development and sustainable water resource management in the sub-regions. Major catchments shared by the regions include the Ciliwung and Cisadane. The Ciliwung and Cisadane catchments runs across several municipalities in *Jabodetabekpunjur*. The upper reach of the catchments overlap administratively with Bogor City and Bogor Regency. In this sense, development activities in Greater Bogor have significant impact on the quantity and quality of water resources in the catchments. Increasing built environment, extraction of surface and groundwater for consumption, and point and diffuse sources of pollution along the waterways have significant impacts on the shared hydrological system. Currently, the frequency of flooding in the lower reach of the catchments has increased, partly associated with increased development activities in the upper reaches. Climate change is likely to further increase the flood intensity and frequency and the occurrence of drought.

Against this background, the tension between pursuing economic growth in Greater Bogor and the negative environmental consequences that flow outward into other cities and regions need to be carefully considered in the city and regional planning and development processes. The future of regional development and the critical function of the interconnected water systems rest on the goodwill and cooperation between local and national governments that can bring to the forefront a commitment to a sustainable development agenda. Each city/region needs to consider their critical role and place in the shared resource systems to prevent and mitigate negative consequences of development activities within their jurisdiction and the flow-on effects of those activities across administrative boundaries.

2.2. BIOPHYSICAL DESCRIPTION

Bogor metropolitan area is located approximately 60 km south of Jakarta. This proximity means many residents commute to work in Jakarta or have a primary residence in Jakarta and second or “holiday home” in Bogor. Located at a higher elevation than Jakarta, Bogor is generally cooler than the capital. Bogor encompasses the municipalities of Kota Bogor (Bogor City) and Kabupaten Bogor (Bogor Regency).

The topography of Bogor is uneven, steep in parts and ranging from 190 to 330 m above sea level. It is located in a basin between two volcanoes; Salak and Gunung Gede. The Ciliwung and Cisadane rivers (the Cisadane is the larger by basin area and annual discharge volume) flow south to north through the urban area of Greater Bogor The groundwater system includes a number of deep aquifers, shallow aquifers and various springs. There are several small lakes in Bogor City and 95 lakes across Bogor Regency, though far fewer within Greater Bogor itself. A legacy from its colonial past is the open channel drainage system throughout the city; once used as agricultural irrigation channels they have now largely been repurposed for urban drainage.

Bogor is known as 'the Rain City' due to its high rainfall, averaging 2,700 mm/year. There is some variation across Greater Bogor, with annual rainfall reported to range from 1,300 mm/year to 4,300 mm/year. The climate of Bogor is tropical, with seasons divided into 'wet' and 'dry'. January and February are generally the wettest months in Bogor, averaging 450-500 mm/month. Monthly rainfall tends to be lowest in June, July and August, in the order of 100 mm/month or less. Flooding may sometimes occur late in the wet season.

2.3. GOVERNANCE AND SOCIO-ECONOMIC FEATURES OF BOGOR

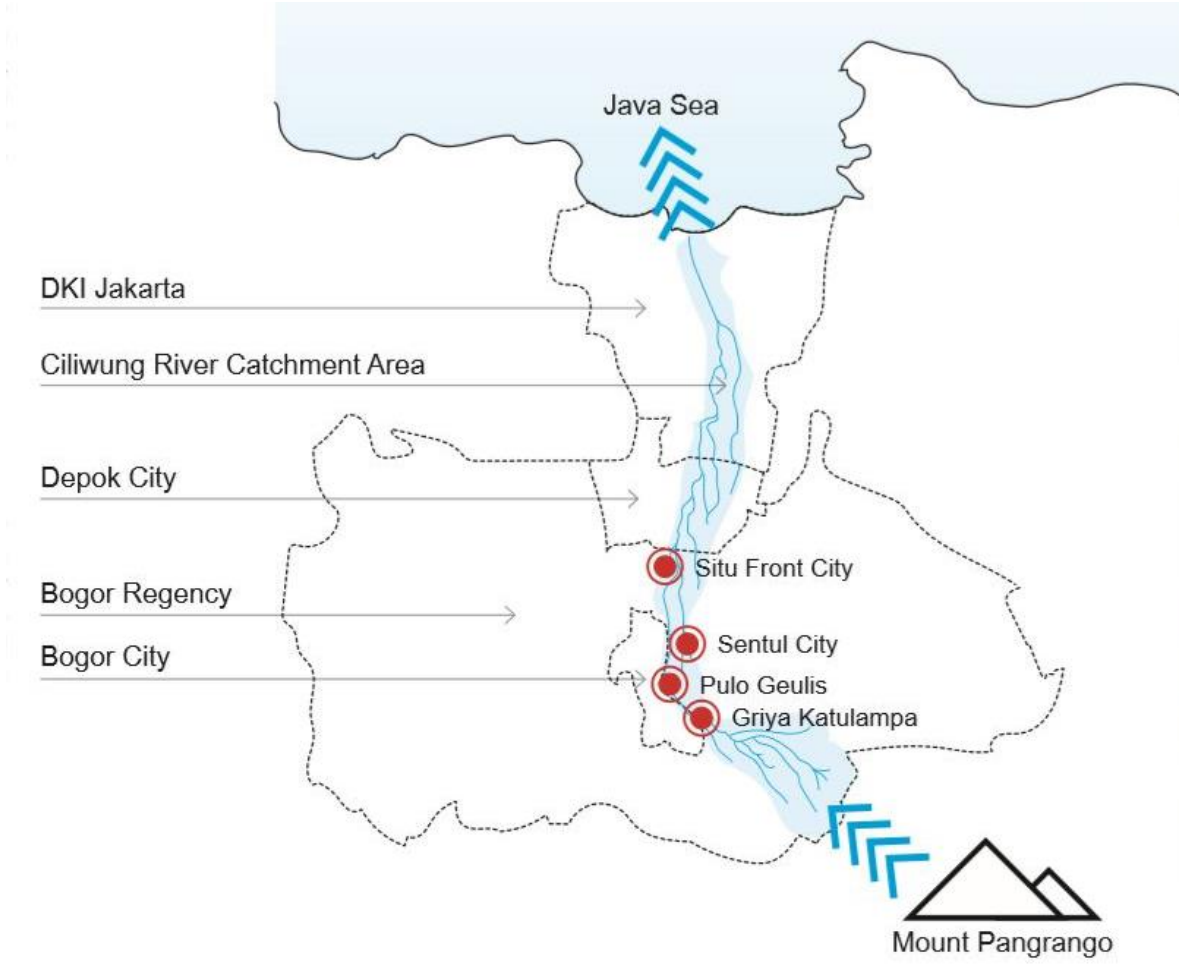


Figure 2. The regional context and location of the 4 case study sites with respect to the Ciliwung catchment

The study area comprises two municipalities within the province of West Java. This includes the whole of the municipality of Kota Bogor (Bogor City), which has an area of 118.5 km^2 and population of 1,016,687 (2016). The surrounding municipality of Bogor Regency includes satellite suburbs of Bogor such as Cibinong, Ciomas and Sentul City, but also a large area of rural land with no urban connection to Bogor metropolitan area. As most economic and social data is published at the scale of municipalities, it is difficult to draw an accurate assessment of Greater Bogor as a whole. The population of Bogor City in addition to the Bogor Regency districts (*Kecamatan*) adjoining the Bogor City boundary is approximately 3.3 million people. This population figure likely includes some rural residents in Bogor's peri-urban area.

Water resources management and the provision of water services are predominantly public sector activities in Indonesia. Each municipality in the study area operates a government-owned enterprise responsible for water distribution (a *PDAM*) and operates sewerage services internally. Nevertheless, due to the low reliability of centralised potable water supplies, private sector bottled water businesses are an important part of the urban water picture.

The responsibilities for water management are defined by laws covering a range of functions subject to decentralisation as well as regulation specific to water services. The general principle is that a local government has responsibility for waterways and water services that are contained within its boundaries. When there are cross-boundary impacts with another government at the same level, jurisdiction is assigned to the next level up in the government hierarchy, such that rivers that flow through multiple provinces are the responsibility of the national government. This is the case for the Ciliwung and the Cisadane rivers. Despite this principle of decentralisation, most water utility responsibilities are functionally managed at the local government level, whereby each City or Regency government will operate its own water supply business and wastewater collection and treatment system.

2.4. SUMMARY OF BENCHMARKING OF BOGOR'S WSC PERFORMANCE

Benchmarking Approach

The current performance of water planning and management in Greater Bogor is measured using the water sensitive city framework, which takes a holistic and integrated view of urban water systems and their role in supporting the resilience, liveability, productivity and sustainability of cities. The tool used for benchmarking is the Water Sensitive Cities Index (WSC Index), developed by the Cooperative Research Centre for Water Sensitive Cities. It enables diagnosis of key strengths and improvement needs for 34 indicators across 7 goals to inform prioritisation of actions and provide a framework for ongoing monitoring and evaluation of a city's water sensitive performance.

Assessment with the WSC Index's involves engagement with key sectoral stakeholders for the region under investigation. The professional judgement of experts, as well as primary and secondary evidence relevant to Bogor's water

system, was used to determine a score out of 5, based on the criteria defined for each indicator.

WSC Index Results for Greater Bogor

Figure 3 summarises the performance of Greater Bogor, averaged across the indicators for each of the 7 goals of a water sensitive city. The average scores are relatively even for the goals, in the range of 2.0-2.7. The highest average goal score was for *Increase community capital (*2.7) and the lowest was for *Ensure quality urban space* (2).

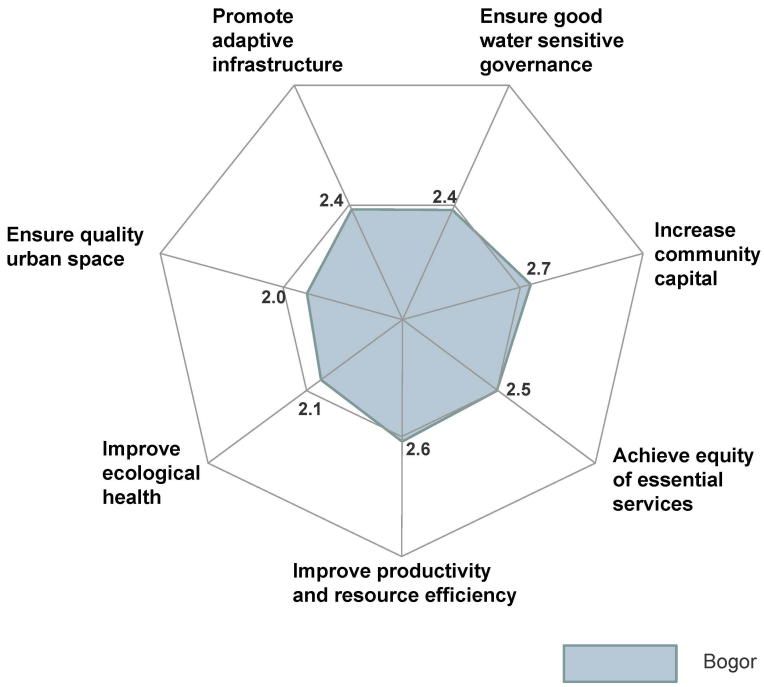


Figure 3. Summary of Index results according to the goals of the WSC Index

Analysis of the rationale for indicator scores within each goal reveals more insight into Greater Bogor's water sensitive performance.

Ensure good water sensitive governance (2.4 out of 5)

Research indicates that sustainability is afforded some prioritisation in government strategies, although in practice urban development is typically prioritised over sustainable and integrated water management, and the traditional delivery of essential water-related services dominates funding decisions. Integrated water planning is largely absent from strategic consideration and there is a skills shortages, especially beyond the dominance of traditional engineering approaches (e.g. knowledge of green infrastructure).

There are legal requirements for representation and community inclusion. Greater Bogor governments have encouraged public participation in water management by initiating collaborations with civil society organisations such as Sanitaria and Forum Kota Sehat Bogor for user-managed infrastructure and environmental volunteering (e.g. Eco Village Community river clean-ups). However, in strategic planning, engagement typically takes the form of information delivery rather than residents influencing decisions.

Some cross-sector institutional arrangements are present, but there are gaps in coordination and information exchange, for example in groundwater extraction approvals, and project-based collaboration is rare.

Increase community capital (2.7 out of 5)

There is increasing community participation in water-related education activities. Environmental education is institutionalised at different levels of schooling. Some parts of the community in Bogor have strong connections with their local waterbodies and environments, such as residents of Pulo Guelis, which lies between two anabranches, or Griya Katulampa, which relies on locally sourced groundwater. There is a high level of shared ownership and management of water assets such as wells and wastewater distribution systems, though there are gaps in responsibility for resource management and maintenance that have affected groundwater supplies in the city.

Disaster response is generally well-coordinated. Social media and message services strengthen community responses to disaster as they are used to share information about imminent events and are sometimes coupled with early warning systems. Some agencies facilitate flood preparation and mitigation, including large-scale community operated rainwater infiltration wells. It is not clear how well informed the public is about disaster response plans, however.

Achieve equity of essential services (2.5 out of 5)

Water supply is generally reliable, though slightly less than half of households are considered to have access to decent potable water supply to the home. Most households have private sanitation facilities, nearly all of which are connected to onsite septic systems, although with variable maintenance regimes.

Flooding tends not to be a significant hazard in Greater Bogor itself; it is more a concern for areas downstream of Bogor, which creates a need for better management of urban runoff. However, some recent floods have caused loss of life in Bogor, and is generally disruptive of everyday activities.

Water-related assets offer amenity values in several areas of the city, though access is generally difficult.

Improve productivity and resource efficiency (2.6 out of 5)

End-user potable water consumption is low. However, the physical and administrative losses in the system (i.e. leaking pipes and water theft) are high and

estimated at about 50%. There are quite low levels of resource recovery, limited to small-scale reuse of sewage sludge.

On a local scale, different small-scale business opportunities are present. For example, floating fish cages are used widely for fish breeding in different water bodies. However, virtually no water-related benefits are made for other sectors through water-related services.

Improve ecological health (2.3 out of 5)

There are some areas of healthy and biodiverse habitat, with some functioning ecological systems given the development context, but overall there is a need for greater habitat connectivity. There is policy in place to conserve areas with significant ecological value, with mapping of vulnerability to identify areas of high ecological value.

There is some action to treat wastewater, but this is limited to large-scale industrial polluters. Urban run-off is not managed and domestic septic systems are generally poorly maintained. Surface and groundwater quality is poor in many areas. Groundwater abstraction is leading to aquifer depletion in some areas.

Ensure quality urban space (2.0 out of 5)

Pleasant urban green space is scattered throughout the city, but is difficult to access and not well-connected. However, there is policy to improve connectivity and accessibility, centred on the botanical gardens. There has been some implementation of green infrastructure in high-profile demonstration sites to fulfil stormwater water treatment, groundwater infiltration and amenity functions, though overall only a small proportion of urban space functions as an integral part of the water system. Bogor has a low degree (approximately 11%) of vegetation canopy coverage.

Promote adaptive infrastructure (2.4 out of 5)

The water system is supplied by a centralised network of treated surface and groundwater as well as dispersed untreated domestic groundwater from small bores and springs. There is a reasonable degree of flexibility for consumers with sufficient financial resources. There are some examples of multi-purpose water system infrastructure in Bogor (e.g. situ), but there are no policies or strategic management approaches in place that support this multi-functionality. The water system is sensitive to stresses with moderate failure rates and drainage inefficiencies. There is a fair degree of decentralisation and use of onsite systems, though there is a need for more integration, and system maintenance overall needs more attention.

Analysis with the Urban Water Transitions Framework

The indicators of the WSC Index are mapped to six states of water system performance, adapted from the Urban Water Transitions Framework (Brown et al., 2009). Cities achieve certain performance markers associated with the priorities of the six developmental states of the Urban Water Transitions Framework as they journey towards a water sensitive city. This transition journey is not necessarily

linear, as a city may show indicators of later developmental states (e.g. waterways, water cycle and water sensitive city) while not fully satisfying earlier states (e.g. water supply, sewered and drained city).

Figure 4 summarises the benchmarking results for Greater Bogor analysed and measured against progress represented by the city-states. Percentage attainment for each city-state ranged from 67% as a water supply city and sewered city through to 0% as a water sensitive city.

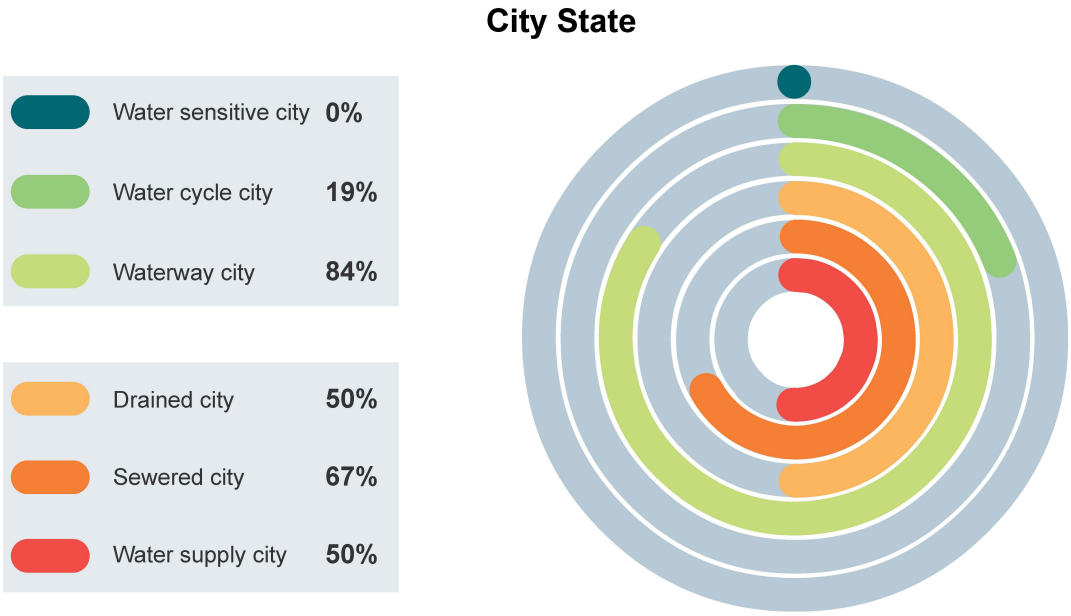


Figure 4. Benchmarking results for Greater Bogor analysed and measured against progress represented by the city-states

50% Water supply city and 67% Sewered city

The water supply and sewered city states reflect the provision of basic supply and drainage services in a city, typically through centralised hydraulic systems. In Bogor, there is limited accessibility and reliability of safe and reliable water supply and sanitation services for a large proportion of residents which will need attention to improve these scores.

50% Drained city

A drained city has infrastructure in place to drain stormwater away from built up areas and protect people and property from floods. Due to its wet tropics climate, Bogor regularly experiences intense rainfall events that stress the drainage system. Drainage channels regularly accumulate sediment and litter due to poor erosion control and domestic solid waste management. Interconnections between the drainage system and the irrigation system effectively reduce the capacity and function of both systems.

84% Waterways city

A waterways city state marks the shift towards valuing waterways for more than just their drainage function, such as amenity and ecological health. There is encouragement of public participation in water system management, and the community has some connection to water and awareness of water issues such as flooding and groundwater replenishment. Many residents also participate in agriculture and aquaculture activities that are dependent on natural water. However, pollution of waterways is persistent, with wastewater treatment mostly limited to large industrial discharges and urban runoff treatment non-existent. Improvement in this score will require a sense of environmental stewardship to be more widely practiced by Bogor's community, with both point and diffuse sources of water pollution controlled.

19% Water cycle city

A water cycle city reflects a paradigm of integrated water cycle management, based on principles of water efficiency, diverse water resources and fit-for-purpose consumption. Some elements of these attributes are being met in Bogor, although often not through strategic system planning and design. Integrating elements of urban form such as drainage and open space into the urban water system will help achieve a water cycle approach, as well as a more dedicated strategy for managing the whole water cycle efficiently.

0% Water sensitive city

Most cities begin their progression to a water sensitive city by achieving high levels of equity in access to safe and secure water supplies and safe sanitation. Although this is a priority for all governments concerning Bogor, there remain financial, technological and institutional barriers to be overcome. For Bogor to become a Water sensitive city, it will also need to fulfil the multiple objectives of ecosystem protection and restoration, security of supply, flood control, public health, amenity, liveability and economic sustainability, among others.

2.5. KEY WATER ISSUES & CHALLENGES

The issues identified through the above benchmarking analysis may be consolidated to the following long-term systemic challenges that this Strategy aims to address.

Long-term water supply planning responding to urban population and climate drivers

There lacks an integrated water supply & demand strategy for the whole of Greater Bogor. Unsustainable levels of groundwater abstraction, which is largely uncontrolled for domestic use, is also beset by quality issues due to poor wastewater management. System resilience is weak as supply is vulnerable to seasonal shortages and moderate failure rates. Infrastructure is ageing and there is little forward planning for asset renewal. Although climate change is a real concern for urban planners, effective adaptation planning has yet to be integrated into formal decision-making processes. The fragmentation of water services along municipal boundaries affects network efficiencies and organisational capacity.

Limited resources for implementing sustainable solutions

Typical funding arrangements favour short-term priorities; planning for long-term sustainability is poorly resourced. For example, the historical legacy of land use planning has left limited scope for the retrofit of improved urban services such as communal sanitation or urban runoff treatment. Use of and access to existing open space is highly contested, leaving little room for passive green infrastructure and improved biodiversity connectivity. There is a preferential focus on hard infrastructure and traditional engineered solutions. Enforcement of existing regulations is challenging for local government under current resourcing arrangements, diminishing the case for new regulations and other non-structural approaches to water system management.

Degradation of water bodies

Threats to waterways and situ include encroachment on buffer zones by settlements, degradation of the riparian vegetation, polluted inflows of stormwater, greywater, and blackwater, and accumulation of solid waste.

Excess stormwater runoff

There is inadequate management of stormwater runoff, which causes minor flooding in Greater Bogor, but with the potential for more significant downstream impacts. There is little implementation of onsite retention, and the drainage system is not managed in an integrated way and is vulnerable to overloading and blockage.

Community attitudes to ecosystem services

Although local water management wisdom is well regarded, for example in the application of rainwater infiltration wells, interest in water sensitive practices is not common. This is evident in the prevalence of litter in waterways and apparent barriers to safe wastewater and greywater treatment. In general, community environmental and water management knowledge is not strong.

Limited local expertise to enable WSC outcomes

There is a critical need for capacity-building within government agencies in practices that can enable WSC outcomes. Gaps identified in this research include knowledge of WSC concepts and non-structural approaches to delivering WSC solutions, and capacity to enable collaborative governance and increased community engagement in WSC outcomes.

Chapter 3

Envisioning Bogor's water sensitive future

3. ENVISIONING BOGOR'S WATER SENSITIVE FUTURE

3.1. WHY DOES BOGOR NEED TO BECOME WATER SENSITIVE?

Greater Bogor, geographically situated in the upper reach of the Ciliwung and Cisadane catchments, plays a critical role in shaping the region's carrying capacity. While municipalities in Greater Bogor have shown a level of environmental commitment by pursuing a green city agenda (based on protection of biodiversity hotspots, natural forests and reserve areas), more can be done in terms of transitioning towards holistic and sustainable approaches in addressing urban water needs and mitigating the downstream impacts of urban development. The WSC framework, which focuses on harnessing cities' capacity to function as a water supply catchment and deliver ecosystem services, can guide organisations to develop future urban water systems that can support growth while protecting environmental quality.

The discussion of water issues in chapter 2 shows Bogor faces challenges to its long-term resilience and sustainability on several fronts. By adopting the WSC approach, Bogor's urban water transition can be directed towards recycling and reusing the urban stormwater and greywater systems as potential alternative resources that can augment existing urban water supplies, while reducing environmental pollution. Furthermore, development of blue and green corridors along the waterways using green technologies to improve stormwater quality can also deliver ecosystem values and enhance urban liveability.

Upgrading urban water systems with WSC principles should lead to managing existing and future water retention basins (*situ* or lakes) across Bogor as an integrated part of the whole urban water system. While there are considerable numbers of *situ* across Bogor, their storage capacities are reduced due to long-term sedimentation and land reclamation activities. Viewed through a water sensitive lens, these *situ* represent opportunities for managing flood impacts and augmenting water supply systems. Through urban planning and design, they can also be integrated into the surrounding built environment to enhance amenity and to provide recreational and ecosystem values.

Outlined above are the major opportunities for transitioning towards a WSC in Bogor. Strategic decisions made today can determine whether Bogor's urban water future can be aligned with sustainable development agendas. There are opportunities for Bogor to develop urban water systems that are based on WSC principles, capable of delivering multiple functions and benefits from diversification of water supply sources, improvement of waterways quality, provision of ecosystem values, alleviation of flood risks, to enhancing urban liveability. These opportunities are further explored in more depth in Section 4.

3.2. VISION OF BOGOR AS A WSC IN 2045

In this section, knowledge of the key regional and local drivers, as well as the rationale for becoming a WSC, are utilised to inform a preliminary overarching vision of Bogor as a WSC in 2045 that is used to guide this Leapfrogging Strategy. The vision is understood as a high-level narrative that can guide the formulation of context-specific transition pathways to achieve urban water outcomes that are aligned with water sensitive city principles. The value of the vision lies in its ability to articulate shared values and desired outcomes. The persuasive power of a sustainable future vision of Bogor can also drive actions, influence development agendas, and generate buy-ins from a range of stakeholders who need to be involved in realising the vision.

The year 2045 is chosen considering its national significance as a year in which Indonesia will celebrate a century of its independence from colonialisation. It thus represents an important point in time whereby the country would take stock and celebrate its developmental achievements in terms of key social, economic and ecological outcomes. Broadly conceived, the 2045 future vision of Bogor as a water sensitive city is one in which sustainable urban water management outcomes are achieved and can be widely celebrated on a national as well as global scale. More specifically, the vision includes the elements in Box 1.

Box 1. Preliminary vision of Bogor as a WSC in 2045

1. Clean, rehabilitated waterways and high biodiversity that is supported by healthy water systems
2. Capture and treatment of rainwater and stormwater in the urban catchment to reduce downstream flooding and augment water supply sources
3. Use of green, irrigated open space to reduce the impact of urban heat island effects
4. Urban development underpinned by a shared responsibility across governments, private sector, civil society, research organisations and community members
5. High level commitment and collaboration among stakeholders realised through a highly participatory, gender and ethnically sensitive, and equitable decision-making process
6. Catchment-wide institutional reform agenda to manage upstream-downstream development impacts in the greater metropolitan regions of *Jabodetabekpunjur*
7. Highly water literate communities that respect water resources and have capacity to contribute to the operation and maintenance of distributed green infrastructure systems
8. Incorporation of traditional water wisdom into water planning and engagement with local connections to waterways, including the connections of informal settlements.

Some elements of this vision can already be found in practice on a smaller scale in Bogor. For instance, in one of the case studies, Pulo Geulis, locally-driven pilot

projects for biofilters, communal septic tanks, and small-scale urban agriculture can already be found. Furthermore, in this site there is a strong sense of shared responsibility among the community members in preserving local cultural practices, which can be leveraged to institutionalise water sensitive practices. Connections to the adjoining river, including day-to-day communal activities ranging from washing, bathing, fish production and public gathering, are also critically shaping the urban water practices at this site.

Informal settlements such as Pulo Geulis form a key part of Bogor's future WSC vision. The roadmap for Pulo Geulis to become water sensitive (refer to ***Pulo Geulis Revitalisation 2045: Urban Design and Implementation Roadmap***) has identified a number of potential opportunities to develop local urban water systems that are aligned with the WSC principles. In a similar manner, some elements of the WSC vision have also informed local practices and development processes in the other case study sites, such as Griya Katulampa, Sentul City and Situ Front City. In Situ Front City, the concept of blue and green corridors has been utilised as a key design element in the master plan of the new development areas. Enhanced with WSC vision and design principles, the development of the Situ Front City can include a wider range of multifunctional green infrastructures that deliver additional socio-ecological benefits.

It is noted that while the vision sets a desired future for Bogor at city and catchment scale, the strategies discussed in the next section are broad in scope and designed to enable change towards water sensitive outcomes, starting with the short-term. In this sense, the suite of pathways can be further refined and expanded to realise the ambitious vision. However, the value of the vision as an ambitious, yet persuasive, tool remains important to drive agenda setting and adoption of the transition pathways in practice.

Chapter 4

Leapfrogging to a water sensitive Bogor

4. LEAPFROGGING TO A WATER SENSITIVE BOGOR

4.1. 'LEAPFROGGING' IN THE PRESENT CONTEXT

To realise Bogor's water sensitive city vision by 2045, 'leapfrogging' pathways need to be identified to direct future urban water-related investments and activities. Leapfrogging, as introduced in Section 1.1, is a relatively new concept used to explain the possibility of emerging economies, which have yet to invest heavily in production and consumption systems of the industrial world, to avoid these unsustainable systems in favour of forward-thinking sustainable systems of production and consumption (Perkins, 2003; Binz *et al.*, 2012).

The benefit of leapfrogging is considerable given the potential to avoid replicating the investment that developed economies have often made into what have proved to be inefficient systems that may come to represent a technological 'dead-end' in the context of a sustainable, water sensitive, or carbon neutral future. Within the urban water sector, water sensitive city approaches are proposed as alternative sustainable solutions that a developing city like Bogor can adopt in place of unsustainable systems, including single-function assets, centralised water infrastructure, and carbon-intensive treatment.

Despite the argued receptivity of emerging economies to technological leapfrogging, facilitating leapfrogging may still require radical changes to wide-ranging technical, organisational, and institutional structures. Cross-sectoral, multi-objective development strategies that take a systemic approach are typically required.

The design of this project has aimed to establish local enablers of innovation and learning. It has engaged innovators at key universities in the region and connected them to a global partner with expertise in transition governance, modelling for hydrological resilience, and green infrastructure technology design. The project has also served as an interface for dissemination of technology and decision-making innovation among key government agencies. This approach has also aimed to lay the foundations for institutionalising multi-actor partnerships and collaboration.

International, national, and regional partnerships are central to the idea of leapfrogging (Perkins, 2003). As was the case in this project, foreign donors and industry partners provide an important source of funding and information systems to foster learning and develop leapfrogging technologies. Importantly, local academics, practice communities, and civil society can play an instrumental role in driving on-ground changes and building public credibility that support implementation of the new radical approaches. In short, leapfrogging requires an across-the-board assessment of capabilities and setting of specific targets that can drive on-ground practical actions.

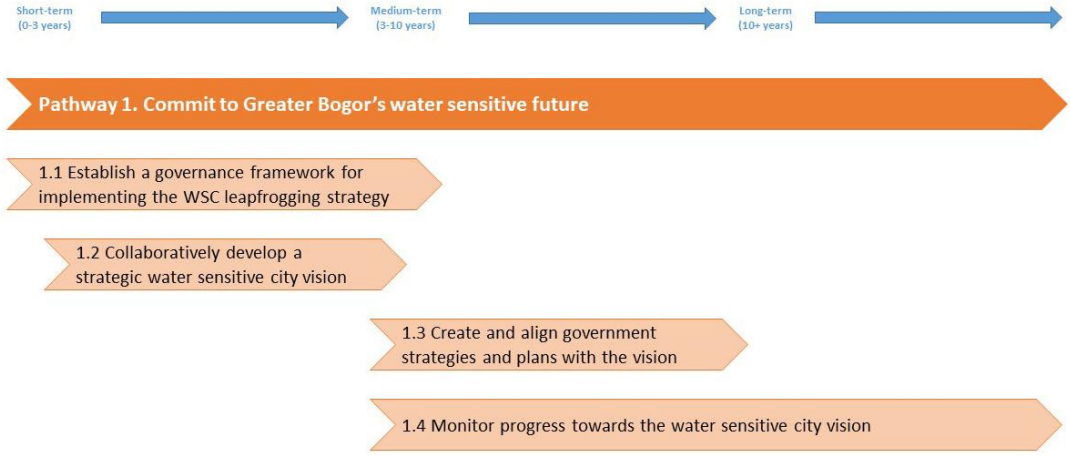
In the next subsections, specific leapfrogging pathways are presented with reference to Bogor's vision for WSC, the benchmarking results of Bogor's existing water systems' performance and the key issues and challenges that need to be addressed. The aim is to identify priority areas and propose holistic leapfrogging strategies that

can be taken up by government and industry to set a new course of actions that could propel Bogor towards the WSC vision.

4.2. LEAPFROGGING PATHWAYS

Pathway 1: Commit to Greater Bogor's water sensitive future

This pathway establishes overarching structures to guide future transition actions



1.1 Establish a governance framework for implementing the leapfrogging strategy

Ongoing coordination and support from key agencies are needed to shape innovative and adaptive strategic water management. Immediate establishment of a working party to review and discuss in more detail the outcomes and recommendations of WSC research would help to codevelop a forward plan for addressing key priorities.

The first output of the working party could be a governance framework that addresses collective roles and responsibilities, shared learning needs, leadership capacity-building, and other directions for implementing key enablers of the water sensitive transition. For example, the governance framework might also establish principles for assessing candidate demonstration projects.

It is recommended that all agencies with a stake in Greater Bogor's urban water system be involved as part of the governance framework. This includes water suppliers, health and environment departments, resource managers, land use planning agencies, and development agencies. It would be beneficial for other organisations to be invited to participate, such as major water users, NGOs, and significant owners or managers of green space, such as the botanic gardens.

1.2 Collaboratively develop a strategic water sensitive city vision

A significant first step in achieving water sensitive governance involves generating a collective vision regarding what is desired and feasible for Greater Bogor in the long-term. A strategic vision for Greater Bogor, founded on water sensitive principles and building on pride in the city's existing attributes, will help build broad political and policy support for transforming practices and urban spaces to become water sensitive.

The process of creating the vision is an important intervention in bringing a broad range of actors together to build a common understanding of what is desired and what is possible within a water sensitive scenario. A major component of establishing this vision would be to align core political, organisational and community agendas, and to inform an agreed-upon trans-disciplinary, co-designed research agenda to guide future developments. Ideally, this process would involve experts in law, policy, geography, sociology, community development, engineering, economics, urban design and other fields.

The Cooperative Research Centre for Water Sensitive Cities (CRCWSC) experience facilitating water sensitive city visions for urban areas in Australia may provide useful guidance for Greater Bogor in developing its water sensitive vision. This experience from Australia has shown that co-developing visions fosters stronger collaboration among public sector agencies, clearer priorities for driving change, and a shared commitment to deliver transition strategies.

1.3 Create and align government strategies and plans with the vision

Embedding Greater Bogor's strategic water sensitive city vision in government strategies and plans will help to institutionalise the commitment as a reflection of local priorities. This will help create clarity around institutional roles in delivering the vision, and help coordinate resource allocation to support implementation. In the context of cities being complex and dynamic social-ecological systems, a coordinated approach to planning is crucial.

Several opportunities to align governments' planning with a water sensitive vision were revealed during this research (see Box 2). To develop a comprehensive, integrated and sustainable urban water and waste management strategic framework, it is recommended that governments consider long-term urban water supply and demand, integrated wastewater management, solid waste management, and whole-of-catchment drainage strategy for specific attention.

Box 2: Water sector strategic opportunities

Long-term urban water supply and demand strategy

Although annual rainfall is high, low storage capacity means that dry season water shortages are becoming more frequent. Network growth to meet stated government commitments will strain existing water supplies. A long-term integrated water supply and demand strategy that addresses projected customer growth and climate forecasts in conjunction with supply augmentation options can support meeting service targets.

Integrated wastewater management strategy

Current planning for city-scale sewerage in Bogor is understood to have support from the central government and currently undergoing environmental effects assessment. In the meantime, there are continued issues with septic system maintenance and effluent treatment. A whole-system integrated wastewater strategy can guide infrastructure development and maintenance in the long-term.

Solid waste management strategy

Although individual waste management initiatives exist, the drainage system remains severely impaired by litter. A robust, comprehensive solid waste management strategy can link and upscale existing initiatives and contribute to lifting Greater Bogor's liveability and ecological health. In doing so, it is important to take a systemic approach by addressing all collection and disposal options as well as behavioural approaches to reduce waste.

Catchment-based drainage strategy

A more integrated catchment management approach to flood mitigation is required, which facilitates cross-boundary action throughout the Ciliwung and Cisadane catchments. Due to the potential for land use change to impact existing drainage infrastructure, an effective drainage strategy needs to integrate urban planning controls with conventional engineering treatments such as use of neighbourhood-scale water retention systems.

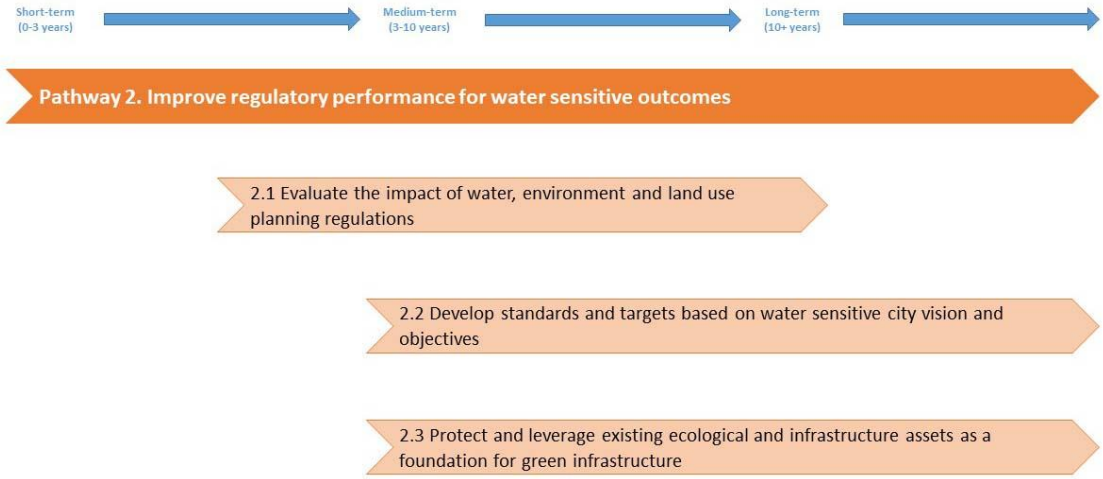
1.4 Monitor progress towards the water sensitive city vision

The WSC Index is a useful tool for establishing a baseline of performance across a wide range of water sensitive city aspirations. The Index also enables water industry stakeholders to see at a glance strengths and improvement needs of a city's water sensitive performance and identify priority actions to improve community outcomes.

Periodic assessment with the WSC Index may be useful for accumulating system information and tracking progress towards Greater Bogor's water sensitive leapfrogging goals. It can also help maintain connection with a global community of practice involved in application of the WSC Index.

Pathway 2: Improve regulatory performance for water sensitive outcomes

This pathway focuses on planning controls that mitigate the environmental impacts of urban development



2.1 Evaluate the impact of water, environment and land use planning regulations

Stakeholders in Bogor reported difficulties in designing regulation to suit water sensitive city goals, translating existing policy objectives into enforceable regulation, and resourcing effective compliance and enforcement. This appears to be common throughout Indonesia.

Overcoming these challenges will take time as it involves aligned action by all levels of government. Local government can take steps in the short-term to develop its regulatory practice by evaluating the performance of current regulation in meeting the intended outcomes, and its potential for enabling and driving the aspired water sensitive outcomes. The type of measures that are likely to be relevant to evaluation include the impact on the ultimate issue of concern, and cost-effectiveness of the regulation or the net benefits. Evaluation using a net benefits approach provides an advantage over cost-effectiveness as it takes into account a broader set of values.

2.2 Develop standards and targets based on the water sensitive city vision and objectives

Water system and land use standards and targets to meet Greater Bogor's water sensitive city vision will help establish performance objectives while allowing flexible deployment of water sensitive solutions. For example, setting minimum performance standards for runoff quality and volume reduction in new developments could help to enforce the use of stormwater treatment technologies. Other standards and targets may relate to acceptable flood levels and recurrence, piped water consumption, and green open space as a proportion of new developments or rebuilding. This is necessary to reflect national priorities for spatial planning to accommodate the environmental capacity of the region.

Standards and targets are best established through negotiated processes that capture community values and priorities and reflect local system data. However, in

the short-term there may be value in reviewing those in use in similar jurisdictions to determine their potential suitability for interim use in Greater Bogor.

As achievement of standards and targets in practice is more likely when there is accompanying technical guidance (also see strategy *6.3 Develop guidance and training for planning and designing water sensitive solutions*).

2.3 Protect and leverage existing ecological and infrastructure assets as a foundation for green infrastructure

There are solid foundations for the adoption of green infrastructure in Bogor, with existing local examples, green technology skills, and ecological assets to build upon. However, green infrastructure installation is most efficient in conjunction with existing areas of ecological productivity, rather than as conversion from built-up, intensively developed land.

Unfortunately, Greater Bogor continues to lose green space through land conversion. Situ have also been lost to redevelopment. Although there are existing protections for green and blue space in landscapes, this does not appear to be sufficient to prevent further decline.

It is recommended that local governments consider actions to prevent loss and degradation of areas of ecological value in Greater Bogor, such as situ and green space, through stronger land use regulations and commitment to enforcement. Enhanced protections for existing assets help create a more certain investment climate for public and private sector upgrades to these assets.

It is also important to better understand the impact of situ and green space loss for a range of local and landscape-level values and benefits, including flood mitigation, water treatment, ecological functioning, and urban liveability. This can help socialise regulations and contribute to better integration of green technologies to enhance green and blue assets' ecological functions.

Pathway 3: Support integration and coordination across water and urban stakeholders

This pathway promotes strategies to improve collective decision-making by formal and informal organisations in the water system

3.1 Facilitate collaboration within and across organisations

Platforms that bring together government agencies, non-government organisations (NGOs), academia and the community to collaborate will help to drive coherent city-wide action to implement Greater Bogor's WSC vision. This collaboration is critical for managing catchment-scale issues such as flooding, water quality and groundwater management.

The recent initiation of an integrated water management forum is a promising step in developing a platform for collaboration. Inviting participation by the non-government sector and academia in such policy forums can promote reform in the typically mono-disciplinary cultures of agencies to introduce innovations. Other approaches might include multi-agency project teams that break down barriers between organisations. Fostering early-stage collaboration on smaller projects, including sharing data and co-funding, can help establish trust for overcoming barriers to achieving catchment-wide outcomes on larger projects. Formal consultation linkages at key planning decision points set out in national laws may also be beneficial in the long term. Professionals with specialist skills and an ability to cross organisational and disciplinary boundaries can be valuable team members in infrastructure and planning units.

Discussions with local government personnel showed that there was considerable interest in supporting new water infrastructure through joint public and private sector funding, which were seen to be effective in the transport sector. While it is beyond the scope of this research to comment in detail, this direction appears to be promising. A likely barrier to attracting private sector investment in the short-term may be a legislative framework that discourages commercial participation in water supply / distribution.

3.2 Conduct inclusive, participatory strategic planning processes

There are two local governments and two water utilities, as well as provincial and central government stakeholders and a range of NGOs and private sector organisations active in high-level water planning and management in Greater Bogor. With responsibility for the water system dispersed among many actors, it is important to take an inclusive and participatory approach to developing long-term water sensitive vision and leapfrogging objectives. As the breadth of transformation to a water sensitive Greater Bogor is also very large, planning necessarily requires the input of diverse knowledges and perspectives.

To effectively implement inclusive planning processes, dedicated resources are needed to identify and target important stakeholders, develop attractive messages to encourage effective engagement, and to facilitate forums for capturing useful feedback for strategic planning purposes. It may take some time to establish productive mechanisms for participation, and it will benefit from embedding in planning processes over the long-term. Naturally, sustained political commitment will be important (see strategy *1.2 Collaboratively develop a strategic water sensitive vision*).

3.3 Develop platforms for sharing data

Mechanisms for sharing data and information are crucial to achieving coordinated planning and infrastructure development. Different organisations likely have unique datasets designed to meet specific organisational needs and managed according to organisational requirements. Collectively this data is useful for managing Bogor's water system in a way that cannot be achieved by a single organisation's data alone.

However, valuable datasets are often inaccessible to external stakeholders whether for security or practical reasons. Different datasets, even those produced by the same organisation, are often incompatible because of differences in the way the data was collected, leading to variance in quality.

New systems and policies can enable data to be accessed and analysed by users across organisations to create integrated outcomes in system planning. This would need investment in systems for standardising data quality control procedures and data management across Greater Bogor, and the development of accessible platforms for sharing data and analysis.

For detailed implementation planning, better connections between different expert communities are important for overcoming policy and technical challenges. Data management working groups comprising stakeholders from different organisations are a model for tackling problems collaboratively. Strengthened partnerships between academia, industry and government may also help develop these approaches.

In addition, agencies could establish stronger cases for investment in new data collection, analytics and dissemination programs guided by an assessment of which datasets are most critical to inform robust decision-making across multiple organisations.

3.4 Advocate for more coherent urban water resource management

Responsibility for Greater Bogor's urban water system is currently dispersed among several organisations. For example, different agencies manage aquifers and groundwater use, groundwater extraction approvals and piped water supply (usually from groundwater sources). Specific examples of gaps in coherent water resource management are detailed in the accompanying report, ***Governance for a Water Sensitive Transition in Greater Bogor***.

Institutional reforms to achieve more effective water system management need careful consideration and direction from central and provincial government. Local government can help to build the case for reform by collecting and reporting supporting evidence, engaging with the community about water management and bringing issues and opportunities to high-level forums.

3.5 Coordinate urban planning and the provision of water infrastructure

Effective coordination in settlement planning and infrastructure development will be important for implementing the vision. Local, provincial and central government agencies have a role to play in the planning and implementation of water sensitive solutions. At the scale of individual projects, better communication and information sharing will help overcome some of the frustration currently experienced by stakeholders, and leverage investment in infrastructure such as road upgrades, drainage, water supply and sanitation to deliver additional water sensitive outcomes.

The planning and design of multifunctional urban spaces can be an exemplar of the benefits of enhanced coordination. Current conditions identified through this research showed that different disciplines were rarely integrated in new urban space design projects. Urban planners and landscape architects should engage with water sensitive designers and practitioners at the outset of development planning to make the best use of available assets and to create multi-functional systems.

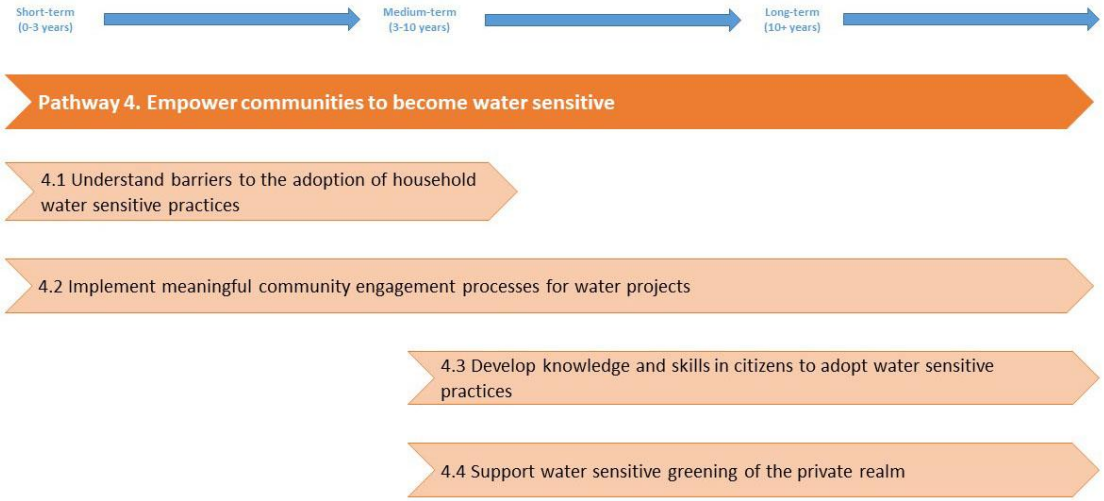
3.6 Strengthen integrated catchment management in land use planning

Moving towards catchment management approaches with sustained resourcing and regulatory integration are important for achieving efficient and equitable planning. This can help deliver outcomes such as reduced development pressure in flood prone areas, decreased stormwater flows in built-up areas, coordinated planning for effective solid waste management, and efficient funding of flood management works.

Efforts to strengthen catchment-based strategic planning would enable settlement planning to achieve integrated outcomes agreed to by all urban and water stakeholders. Advocacy at national and provincial water councils and catchment water resource management councils (Dewan SDA and TKPSDA respectively) will be important. In the long-term, it will be desirable to reform catchment management institutions to empower the intervention in settlement planning in order to achieve agreed catchment management outcomes, drive coordination between local and provincial agencies, and to make use of independent operational funding.

Pathway 4: Empower communities to become water sensitive

This pathway focuses on involving the community in the leapfrogging process through support of new technologies and adoption of sustainable behaviours



4.1 Understand barriers to the adoption of household water sensitive practices

Households represent a major source of potential harm to natural systems, and so community behaviour is an important target for strategic intervention.

To increase the impact of community interventions, it is important to better understand the barriers to adoption of water sensitive practices such as rainwater capture or effective waste disposal. For example, the barriers may relate individuals' perception of their ability to undertake the target practice, which could be from a lack of appropriate information or confidence in their capacity to affect change with the practice. This information can help design more effective strategies to engage the community in desired behaviours, potentially shaping new community education programs or neighbourhood demonstration projects.

4.2 Implement meaningful community engagement processes for water projects

Community participation in strategic planning and infrastructure development is considered by many governments around the world to be important to legitimise decisions, empower compatible community action, and grow acceptance and stewardship of places and developments.

In Greater Bogor, this could be better supported by more consistent and open consultation practices that occur early in the planning approval process and have a genuine impact on decisions. This is likely to need a range of separate initiatives to unfold over the long-term as it is likely to entail negotiating new political understandings with the community and supportive regulation to institutionalise specific consultation systems and practices.

For guidance at the level of engagement practice, the urban design approach proposed by the urban design research team may be considered. This approach aimed to embrace the social and commercial use of public space by providing integrated solutions that can accommodate the current activities and at the same

time provide ecological services and amenity for users. Box 3 summarises some of the engagement activities undertaken for intervention sites as part of the UWC project. The ***Pulo Geulis Revitalisation 2045: Urban Design and Implementation Roadmap*** report provides detailed information on the consultation approach used and how the results of engagement with residents informed the recommended design solutions.

Box 3: Community engagement in the UWC project

The UWC project undertook a range of activities to develop strategies and demonstrate solutions. These included community visioning workshops, co-design activities and consultation.

For Pulo Geulis and Griya Katulampa, community visioning workshops were hosted with residents and stakeholders for the communities. These involved volunteer residents divided into groups of men, women and youth that were facilitated by Indonesian researchers. Activities included:

(i) neighbourhood mapping to identify key sites of concern or potential for redevelopment;
(ii) problem tree activities to facilitate problem analysis in group participation settings; and
(iii) participatory transect walks to document characteristics, problems, likes and dislikes of urban infrastructure in situ.

At the conclusion, a collective vision statement of a more liveable and healthy future was developed.

4.3 Develop skills in citizens to adopt water sensitive practices

Households and individuals are an essential component of the Greater Bogor's water sensitive leapfrogging trajectory, given their potential for significant impact on the water system through their decisions and behaviours. In addition to this, Indonesian citizens are well-recognised for their initiative in improving their own community and environment by the concept of gotong-royong, which describes communal work for a shared objective. These activities have the potential to become an important part of Bogor becoming water sensitive, with appropriate guidance about water sensitive practices and more complete environmental knowledge.

Several knowledge and skills gaps have been identified through this project as being important to overcome to support citizens to implement water sensitive solutions. The understanding of how to prepare for urban flooding and appropriate low risk behaviour to adopt during floods and once flood peaks have passed are considered important to address with many residents. Intensifying sustainable activities already undertaken by residents, for example urban farming and water-related small business, to increase participation and productivity requires skills exchange and extension. Another critical knowledge area is community awareness of climate science, which is an important prerequisite for many water sensitive transition actions.

4.4 Support greening of the private realm

Private green space has the potential to improve connectivity through habitat corridors, and enhance the overall size of the urban green space network. Private open space in Greater Bogor is often allocated to ornamental gardens or small-scale food production.

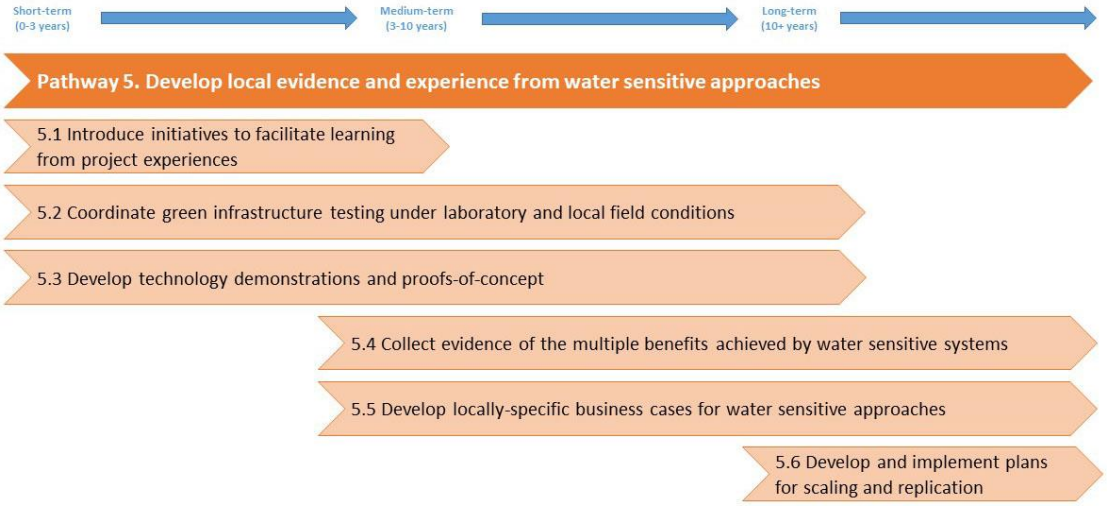
Greening of the private realm is important for Bogor to achieve its vegetation cover target. A range of linked socialisation and behavioural change strategies are recommended alongside planning controls (see strategy *2.2 Develop standards and targets based on the water sensitive city vision and objectives* and strategy *2.3 Protect and leverage existing ecological and infrastructure assets as a foundation for green infrastructure*). Possible activities include:

- Information workshops and forums conducted by environmental groups or universities to raise awareness of the importance of green private space
- Competitions for greening *kampungs*, which have been effective in some areas, and can leverage citizen *gotong-royong* and sponsorship from major Bogor-based industry
- Introducing programs to support local residents' urban greening groups (involving facilitators and/or direct financial assistance)
- Whole-of-city mobilisation behind a 'Green Bogor' by influential political and media figures
- International NGOs and development assistance agencies providing technical support and linking urban greening with health-related engagement

Each of these approaches can be employed in concert to achieve change.

Pathway 5: Develop local evidence and experience from water sensitive approaches

This pathway establishes systems and processes that will help capture knowledge from practical transition innovations and experiments



5.1 Introduce initiatives to facilitate learning from project experiences

It is important to capture lessons of previous and current projects as they are developed and implemented. Databases and case studies in central repositories that are widely accessible to decision-makers, practitioners and researchers would be

useful for this. In Australia, dedicated capacity-building organisations (e.g. Clearwater in Victoria), house online resource libraries that organise case studies by project type.

This type of learning is important for mainstreaming green technology, informing standard-setting and regulation, and supporting innovation among practitioners. In addition, the opportunity to leverage Bogor's expertise, for example in managing the botanic gardens, should not be overlooked. As well as central repositories of information that are widely accessible, it is also important to promote learning from specific projects in place, for example through use of signage and site tours to explain water sensitive projects.

5.2 Coordinate green infrastructure testing under laboratory and local field conditions

Green infrastructure needs to be tested under a variety of conditions to enable designs to be adapted to best suit local conditions and to develop an understanding of appropriate local construction, operation and maintenance procedures and costs. Given the high rainfall volume, intensity and frequency, careful sizing of systems is critical to ensure sufficient treatment capacity. Designing systems to protect them from high flows and high flow velocities is also important (such as incorporating routes for high flows to bypass the system).

Although several organisations in Bogor already undertake testing, its significance needs to be bolstered and its coordination would realise more strategic contributions to practice. Such work is key to providing a foundation for local adoption guidelines for green infrastructure. Information provided in the report, ***Review of the application of green infrastructure for water management in Bogor***, could be used as a starting guide for plant species testing.

5.3 Develop technology demonstrations and proofs of concept

Demonstration projects that provide on-ground examples of an innovative water sensitive solution are critical for local proof-of-concept and as a learning opportunity for stakeholders. It is important to capture all potential lessons from demonstrations, including social, technical and economic evidence and insights, through documentation and dissemination.

Long-term practice change can be fostered through local demonstrations of water sensitive technologies that build confidence in their mainstream adoption. Similarly, a proof of concept can establish the practical feasibility of innovations and show how they provide health, environmental or economic benefits (see strategy 5.4 *Collect evidence of the multiple benefits achieved by water sensitive systems*). Building field demonstrations can contribute performance data to refine design, construction and maintenance practices. A proof-of-concept can also be used to attract private sector participation in demonstration projects, creating private value in terms of profile and branding.

It is common to introduce a demonstration project but fail to capture social insights by communicating with local users or residents and measuring the community response. It will be important to capture all potential learning from demonstrations through

detailed documentation and dissemination, as is the case for projects more generally (see strategy 5.1 *Introduce initiatives to facilitate learning from project experiences*).

5.4 Collect evidence of the multiple benefits achieved by water sensitive systems

Information that quantifies the multiple benefits of water sensitive systems or improves understanding of system costs is important to collect (see Box 4 for benefits of green infrastructure). This information supports efforts to refine systems before committing to scaled-up implementation.

Demonstration projects should be planned and funded for appropriate monitoring and evaluation; performance data that may be useful includes system sizing, loading rate, optimal plant species and filter media. It may be useful to build partnerships with the community sector, academia or international organisations to apply evaluation techniques that capture social, environmental and economic benefits.

Box 4. Benefits of Green Infrastructure

Green infrastructure is based on the concept that natural systems can deliver a range of engineering and human services to the urban area. Potential benefits span the social, economic and environmental domains, and include:

Domain	Benefit
Environmental	- River and lake health resulting from water quality improvement - Flow control and flood reduction - Erosion control - Greywater management - Climate change mitigation - Urban cooling - Air quality improvement - Ecosystem health / biodiversity improvement
Social	- Human health & wellbeing - Community engagement and inclusion - Visual & aesthetics
Economic	- Water supply and security - Economic growth & investment (including commercial vitality, increased property value, local economic productivity - Reduced future cost of grey infrastructure - Thermal benefits to buildings (reduced energy consumption cost)

From ***Review of the application of green infrastructure for water management in Bogor***

5.5 Develop locally-specific business cases for water sensitive approaches

Model business cases for multi-functional water sensitive infrastructure for the local Bogor conditions will be important to show why diverse stakeholders benefit from and

should contribute towards initiatives such as rainwater harvesting or stormwater runoff diversion and treatment in parks and public open space.

For example, it is important to quantify and demonstrate the economic benefits of green water treatment technologies for users in the horticulture and floriculture sector and for the commercial construction sector, such as the value of clean water and fertiliser inputs for the former and building thermoregulation for the latter. Sometimes, the object of demonstration is the business case itself rather than the technology to which the model business case applies.

For Greater Bogor, it may be helpful to develop a model business case for multi-functional infrastructure in Bogor to show why diverse stakeholders benefit from and should contribute towards initiatives such as rainwater harvesting or flood water diversion in parks and public open space.

For more information, refer to the reports, ***Pulo Geulis Revitalisation 2045: Urban Design and Implementation Roadmap*** and ***Situ Front City: Transition Strategy to WSC***.

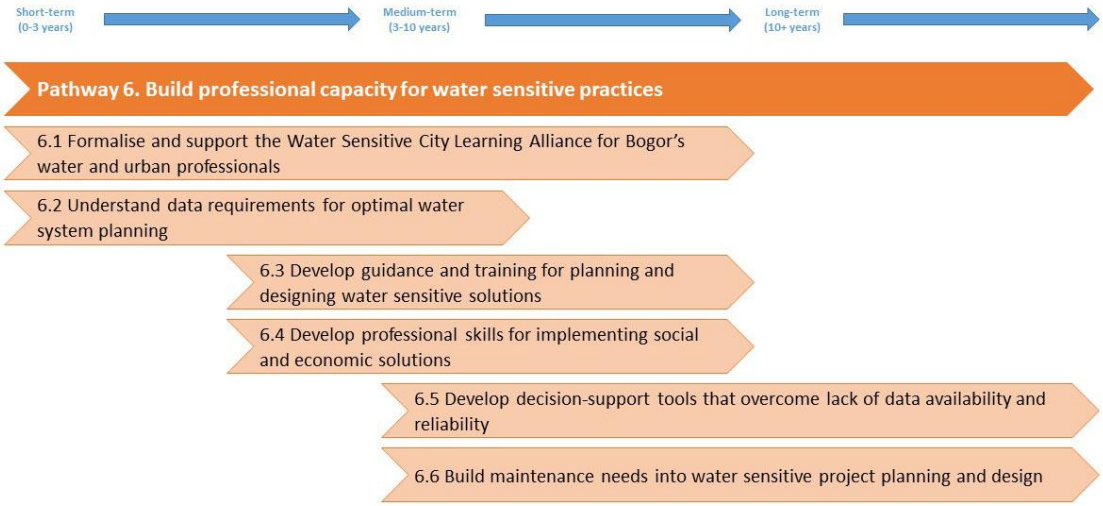
5.6 Develop and implement plans for scaling and replication

Demonstration projects can create significant momentum among stakeholders and potential investors. It is important to develop and implement plans to harness this momentum for scaling and replication of water sensitive projects across Bogor. Dedicated resources to review lessons from demonstration projects will help inform plans to do this efficiently and effectively and show how the project can make a practical contribution to wider adoption of water sensitive approaches.

This planning benefits from efforts to integrate the preparation of design principles, templates or heuristics that support decision-making when local feasibility studies are unable to be undertaken for cost or timeliness reasons.

Pathway 6: Build professional capacity for water sensitive practices

This pathway builds the capacities of water system policymakers and practitioners for implementing the practices to drive a water sensitive leapfrogging trajectory



6.1 Formalise and support the WSC Learning Alliance for Bogor's water and urban professionals

Leapfrogging to a water sensitive city will involve the adoption of new practices and diffusion of water innovations. Professionals involved in these changes, across government, industry and academia, need the opportunity to learn together to build collective knowledge and experience.

Agency leadership is important for formalising the Learning Alliance and facilitating networks that can cut through silos both within and between organisations. Individual water sensitive city champions are important participants in the Learning Alliance to build momentum and influence. Local and international universities, and other research centres with expertise in water sensitive approaches, would be valuable for the Learning Alliance to engage and partner with.

Several governments in Australia have developed platforms to enable public servants to access policy development stories from colleagues, toolkits that have proven successful, and learnings from projects. They are useful in connecting a community of practice that can assist each other in creating, applying and sharing ideas. More specific to sustainability transitions, the concept of urban living labs, which can involve the co-creation of solutions by system managers and users, may be useful.

6.2 Understand data requirements for water system planning

The lack of data and lack of confidence in data quality is a well-recognised challenge for planning, designing and managing Bogor's integrated water system. Specific data gaps experienced in this project for hydrological modelling include accurate data of flow levels, drainage layout and dimensions, high resolution rainfall records at multiple sites, and a high resolution digital elevation model. This has implications for the ability of regional government to comply with laws requiring spatial planning to address the capacity of the environment to accommodate inputs.

In the long-term, appropriate resourcing for data collection and management should be addressed. However, an immediate action that can be undertaken by local governments is the preparation of a data management framework. This framework would describe the data requirements for water system planning and inform prioritisation of investment in data collection and analysis. It should also define the degree of aggregation suitable for effective decision-making. An example framework may involve water resource and consumption or demand data that enables the design of fit-for-purpose urban water systems.

Although data frameworks should formulate suitable strategies based on a detailed needs analysis and water system objectives for Bogor, it is likely that the foundational datasets recommended in the strategy would include:

- Detailed surface drainage network asset information (e.g. location, levels within the drainage network, dimensions)
- High resolution aerial imagery (e.g. LIDAR data)
- Groundwater data (e.g. groundwater levels, quality, bore locations)
- High resolution rainfall levels

6.3 Develop guidance and training for planning and designing water sensitive solutions

At present there is limited practical guidance for industry or local government on how to implement water sensitive technologies in Bogor, or in fact Indonesian cities more broadly. Existing knowledge is mainly captured in academic reports or held by specific consultants. Guidelines for the implementation of technical solutions such as green infrastructure would help to promote widespread adoption of water sensitive approaches (see Box 5).

While comprehensive guidance based on local evidence is desirable over the long-term, initial steps could focus on assessing the suitability of existing guidance from other jurisdictions and making adaptations for local use.

Technical advice from universities and international agencies may be useful to inform planning and design guidance. Relevant agencies may find it useful to promote general training and capacity building in the application of existing planning and design tools.

Box 5: Selecting green infrastructure to meet management objectives

When selecting green infrastructure, the most appropriate technologies often differ between sites. This is illustrated by the UWC case studies. Technology selection requires an understanding of the key issues for the site, defining the design objectives, and design that considers the opportunities and constraints of the site. Careful technology selection is thus imperative for optimal benefits at each location. Technologies can be selected and the complexity of designs modified to suit the site and available resources for construction and maintenance. For example, the design of bioretention systems (or raingardens) is highly adaptable and can take the form of simple, passive systems. Benefits can also be achieved by simply directing runoff into passively watered garden beds, similar to Singapore's Soak-away raingarden design (PUB, 2018).

6.4 Develop professional skills for implementing social and economic solutions

Improving the capacity to deliver social and economic interventions to influence a wide range of community and business practices can create new pathways for delivering water sensitive outcomes. Social and economic solutions could include incentive schemes, regulation, participatory processes and community engagement campaigns.

Building public sector skills and capacity to evaluate the full range of implementation options may reveal the most cost-effective means of achieving water sensitive policy objectives. A particular focus on skills to engage in multi-disciplinary programs and innovative multi-stakeholder water projects is important for Bogor. Increased public sector capacity to support community engagement, both in terms of raising community awareness of planning issues through engagement campaigns and systems for integration consultation outcomes into decision-making, may also be important.

6.5 Develop decision-support tools that overcome lack of data availability and reliability

For Bogor, it is useful to understand deficiencies in data quality to reinforce advocacy for improvements (see strategy 6.2 *Understand data requirements for water system planning*). In the meantime, it may be useful to develop robust tools that consolidate and integrate different sources of data, including contextual knowledge as well as new data capturing techniques (e.g. drone surveys), to support planning and decision-making until more comprehensive data can be established.

6.6 Build maintenance needs into water sensitive project planning and design

Improved water infrastructure maintenance is a pressing need for Greater Bogor's existing system. This will continue to be important as green infrastructure is deployed as part of Greater Bogor's transition to a water sensitive city.

To achieve effective operation of green treatment systems, project planning and design benefits from incorporation of maintenance needs at an early stage. Key considerations for initial planning for ongoing maintenance are the degree of sophistication of the system, the scale of its operation and the likely responsible stakeholder and budget allocation for implementing the maintenance regime. Initial design can be tailored to the desirable maintenance regime: simpler systems favour local community-driven maintenance, whereas more sophisticated systems may be suitable if project budget is allocated for appropriate staff training and maintenance activities are possible.

Local governments should also consider the need to address more technical capacity building of the public and private sector to support green technology operation more generally. Staff and community training in broader principles of water sensitive approaches can enhance technical capacity across the board and support wider implementation.

Chapter 5

Towards implementation of Greater Bogor's leapfrogging pathways

5. TOWARDS IMPLEMENTATION OF GREATER BOGOR'S LEAPFROGGING PATHWAYS

5.1. A CASE-BASED APPROACH TO STRATEGY IMPLEMENTATION

The UWC research project selected Greater Bogor to explore the city's potential to leapfrog to a water sensitive future through socio-political and biophysical pathways. The pathways can be implemented across the whole urban and water system to facilitate Greater Bogor's leapfrogging trajectory to a water sensitive future.

The UWC project also applied a development typology approach which resulted in the analysis of neighbourhood-level case studies in four selected sites along the Ciliwung River catchment area of Greater Bogor. The case studies were chosen according to a development typology reflecting a range of spatial, social and economic conditions within the broader city and provide a comprehensive assessment of the different ways in which a city can develop and transform over time, especially in emerging economies.

This section considers how the leapfrogging strategies presented in the previous section can be applied to different development contexts marked by the development typology. It illustrates the suitability of the strategies in general for Greater Bogor's diverse urban form and development needs. Additionally, given different development contexts have different needs and opportunities, this section also highlights the priority strategies applicable to each context using insights from the case studies. This is intended to be helpful in shaping an effective short-term leapfrogging agenda for particular development types. With this understanding, implementation may be planned at the city scale and at the precinct or neighbourhood scale.

Some of the leapfrogging pathways set out in the previous section apply at the whole-city scale. This is particularly true for Pathway 1 (Commit to Greater Bogor's water sensitive future). Unsurprisingly, the leapfrogging strategies within Pathway 1 are expected to be relevant to all development scenarios to the same degree.

Table 1. Development typology derived from project case studies

Development scenario	*Kampung* regeneration	Small-scale consolidation	Precinct-scale mixed use renewal	Greenfield urban expansion
Density	High	Medium	Medium-High	Low-High
Timescale for development	Medium	Long	Short	Medium
Case study	Pulo Geulis, Bogor City	Griya Katulampa, Bogor City	Situ Front City, Bogor Regency	Sentul City, Bogor Regency

The development typology (described in Table 1) involves four broad types: (1) urban regeneration, particularly in the context of high density slums and informal settlements; (2) small-scale urban consolidation and incremental upgrade of low and medium density housing; (3) precinct-scale mixed-use redevelopment of greenfield, greyfield, and brownfield sites; and (4) expansion at existing urban boundaries using predominantly greenfield sites and at low-to-high population densities.

Pulo Geulis is an informal settlement that has developed between two anabranches of the Ciliwung River. Although it has the smallest area of the sites considered here, it has high housing density. Wastewater is generally discharged untreated directly into the river via small pipes. The likely development trajectory for Pulo Geulis is through publicly-financed urban regeneration. Given the potential for protracted negotiations with residents over relocation and the need to shore up public investment, substantial redevelopment is likely more than 5 years away.

Griya Katulampa is a 19 ha neighbourhood located in East Bogor district that was developed in the early 1990s. Most lots include gardens, and there is abundant communal green open space. River water is used for fish ponds. Given a predominantly middle-income community and medium-density settlement pattern, development over the next 25 years will likely take the form of small-scale urban consolidation.

Situ Front City is a 209 ha precinct that is slated for large-scale mixed use redevelopment to 2045. The site currently incudes three *situ*, small-scale agricultural land and existing residential and commercial development. The current master plan for the site anticipates a mix of medium density housing, recreation, hotels and other commercial development to position the precinct as a significant short-trip tourism destination. Though the development will likely take 25 years to complete, construction of the first stage is expected to begin within 5 years.

Sentul City is a former greenfield site located in hills to the east of Bogor that is partially developed. It is home to permanent residents in luxury gated estates, some small villages, as well as many visitors to its resorts and hotels. It is a significant focus of urban expansion for Bogor Regency planners. Development will continue to roll out over the next 20-30 years.

5.2. LEAPFROGGING WITH *KAMPUNG* REGENERATION

In 2014, 21.8% of Indonesia's urban population was estimated to be living in slums or *kampung* (literally 'village', but in the urban context describes informally planned low income areas; see Zhu & Simarmata, 2015). Despite this, there has been significant improvement over the last 25 years; in 1990, there was an estimated 50.8% living in slums (UN-Habitat, 2016). These areas may have emerged as a response to the inability of institutions to provide adequate housing within the formal market (UN-Habitat, 2015). There is a national legal framework for relocating, rehabilitating and regenerating slum areas with responsibilities for each tier of government, with a preference for enabling residents to remain in the same location, albeit with upgraded housing (Jones, 2017). However, relocation to public high-rise housing in other areas is common, and a source of fear for many residents.

In Bogor City there are several other settlements described as *kumuh* or 'slums' in the mid-term strategy, distributed among eight *kelurahan*. There are also nearly 200 *kampung* in the province of DKI Jakarta located on land not originally designated for residential use, such as beside rivers and the coast, and railways and highways (Cities Alliance, u.d.). Despite their founding on non-residential, often government land, these areas have typically gained legitimacy over time, often accompanied by proof of ownership and payment of property tax (Cities Alliance, u.d.).

The primary source of leapfrogging insights for the urban regeneration scenario is the Pulo Geulis case study. Pulo Geulis is located in *Kelurahan* Babakan Pasar, *Kecamatan* Bogor Tengah, and is less than 300 m from the renowned Bogor Botanical Gardens. It houses approximately 2,600 inhabitants in 3.58 ha, yielding a population density of 700 people per hectare, which is dense even by the standards of Jakarta's informal settlements (Cities Alliance, u.d.). There is virtually no public open space aside from narrow walkways. The prevailing land tenure is by contract of sale or government certificate rather than freehold title.

A majority of residents have access to reticulated water as the water utility delivers water to the island. However, bottled water is a major source of drinking water for most residents. Wastewater management on the island is poor, with most houses on the perimeter discharging untreated waste water (blackwater and greywater) directly to the river via small pipes. Pulo Geulis is serviced by individual septic tanks but proper maintenance is hindered by the lack of vehicular access.

Fluvial flooding is reportedly not problematic as river water levels do not come to within 1.5 m of ground level. However, nuisance flooding does cause issues when heavy rainfall is trapped within the impervious and dense urban environment.

For Pulo Geulis, community organisation and social capital is a key strength. The community has effective informal leadership that has led to several services being performed by residents, including solid waste collection, neighbourhood improvement, and well-being initiatives. The community strength has spurred municipal planning to take advantage of the tourism potential of the site. However, the area is also challenged by overcrowding, insufficient access to adequate sanitation infrastructure, clean water, natural light and public open space, and, despite efforts, inadequate solid waste management. Long-term planning is impeded by the predominance of informal land tenure, with residents fearing urban revitalization solutions that could potentially harm existing occupancy rights.

The challenges for Pulo Geulis are common to other informal settlements in Indonesia. These conditions are well-documented: lack of basic services such as water supply, sanitation and waste collection, substandard housing, overcrowding, and hazardous locations (e.g. subject to flooding). Household income and expenditure is often significantly lower than the average for the urban region.

In areas like Pulo Geulis, it is typical for urban servicing authorities to be constrained by a range of technical and non-technical factors. Technical challenges that may need to be overcome include high household density and constraints associated with marginal land suitability, such as proximity to waterways or other sensitive land uses

(e.g. transport corridors). The other reports in this series should be consulted for guidance on technical solutions for areas such as Pulo Geulis.

Non-technical factors that may impede urban regeneration include the designation of land for uses other than residential, ambiguous land tenure, the perceived difficulty in gaining cost-recovery for new infrastructure, and the potential opposition of residents to construction activity or new living costs. The interdependence of these factors requires strong long-term collaboration from governments, utilities and community representatives. The WSC strategic planning approach is recommended to focus collaboration among stakeholders, unlock tangible benefits in terms of improved urban liveability and infrastructure development, and sustain long-term transformation.

Learning from the Pulo Geulis case study has informed identification of the water sensitive transition priorities for urban revitalisation scenarios. Transition planning should build on existing social capital and enable inclusive and collaborative planning processes. The leapfrogging strategies particularly beneficial to enabling a water sensitive future for *kampung* regeneration scenarios such as Pulo Geulis are set out in Figure 5.

Given the high number of existing residents of these areas, the leapfrogging strategies that come into focus are generally those that encourage inclusive planning processes and community participation in water management (such as strategies 3.2, 4.1, 4.2, 4.3, and 6.6), which are core activities of a water sensitive city. Given the likely complexity of technical water sensitive solutions for a densely populated area, outlined in detail in the case study report for Pulo Geulis, collaborative and coordinated institutional planning and service provision are required (strategies 3.1, 3.4 and 3.5), and land use planning and water professionals would benefit from new skills and training in a range of related water sensitive practices (strategies 5.1, 5.4, 5.6, 6.3, 6.4 and 6.6). As most kampung are unplanned and informal, it is expected that their sensitivity to regulatory intervention will be weak in the short-to-medium term. Therefore, strategies relevant to improving regulation will be less relevant in the near term.

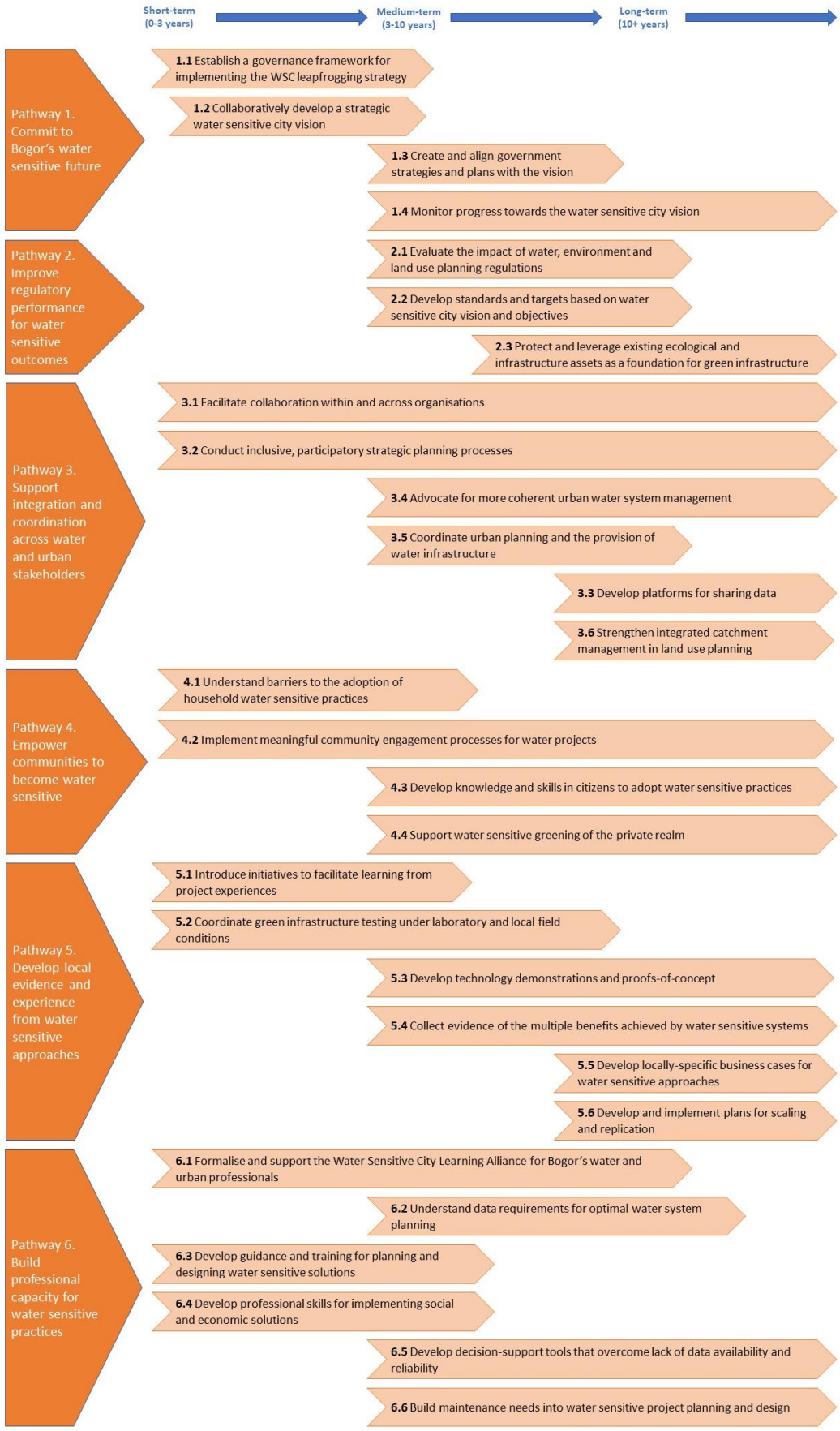


Figure 5. *Kampung* regeneration leapfrogging priorities

5.3. LEAPFROGGING WITH SMALL-SCALE CONSOLIDATION

At smaller scales, urban consolidation often involves redevelopment of small sites into multi-dwelling buildings and small-lot land subdivision, potentially with infill into vacant land or open space. It is generally a market-driven process and can occur over longer timeframes in conjunction with housing turnover (Hurley, Taylor & Dodson, 2017). This form of long-term change is consistent with national policy to increase the effectiveness and efficiency of residential land management in urban areas by increasing density (RPJMN 2015-19).

This case study was centred on Griya Katulampa, a 19 hectare settlement of about 2,250 people located in Katulampa Kelurahan, East Bogor District, Bogor City. The settlement's development began in 1992. Griya Katulumpa occupies a low-to-medium density suburban landscape, as a significant proportion of land in Katulampa Kelurahan remains dedicated to agriculture use. The projected population for 2045 is 2,934 people, with 138 more dwellings expected to be needed.

The area is part of the PDAM Bogor City water supply network, but there is no centralised sewerage. The neighbourhood has strong community bonds connected to collective composting, annual festivals, recreation facilities and green open space.

Located on a site between Ciliwung River and a historic irrigation channel (the first to be built by Dutch colonial authorities), the community has taken advantage of its proximity to fresh water by adopting urban farming practices. Many residents have also exploited a shallow groundwater source, likely sub-surface leakage from the decommissioned irrigation channel, for household and agricultural use. The construction and management of this groundwater system was community-driven.

The challenges for Griya Katulampa are common to many urban areas of Indonesia. Household grey water and stormwater is released to local drains that discharge to the Ciliwung without treatment. Households are served by small-scale septic systems, but likely with inadequate performance. There is some risk of flooding. There are clear opportunities in Griya Katulumpa for improved water treatment, more efficient resource consumption and urban liveability that will result from a transition to a water sensitive city.

The potential green technology solutions to promote in Griya Katulampa and similar settlements include rainwater harvesting and use, biofiltration of stormwater and grey water, and urban farming.

The reprioritised leapfrogging strategies for enabling a water sensitive neighbourhoods undergoing small-scale consolidation are set out in Figure 6. Development in these cases will unfold over a longer timeframe and is reliant on progressive change among thousands of potential landowners and developers. Understanding the current performance and effectiveness of land use and development regulations is therefore critical to planning this change (strategy 2.1), as is understanding barriers to household adoption of water sensitive practices (strategy 4.1). Given the extent of the suburban landscape that is likely to fall within this

change scenario, having certainty about the efficacy of particular green technology solutions for anticipated applications and conditions (strategy 5.2), and providing suitable guidance for implementation (strategy 6.3), are important priorities. Other priority enablers in this scenario are facilitating inter-organisational collaboration and formalising the WSC Learning Alliance (strategies 3.1 and 6.1).

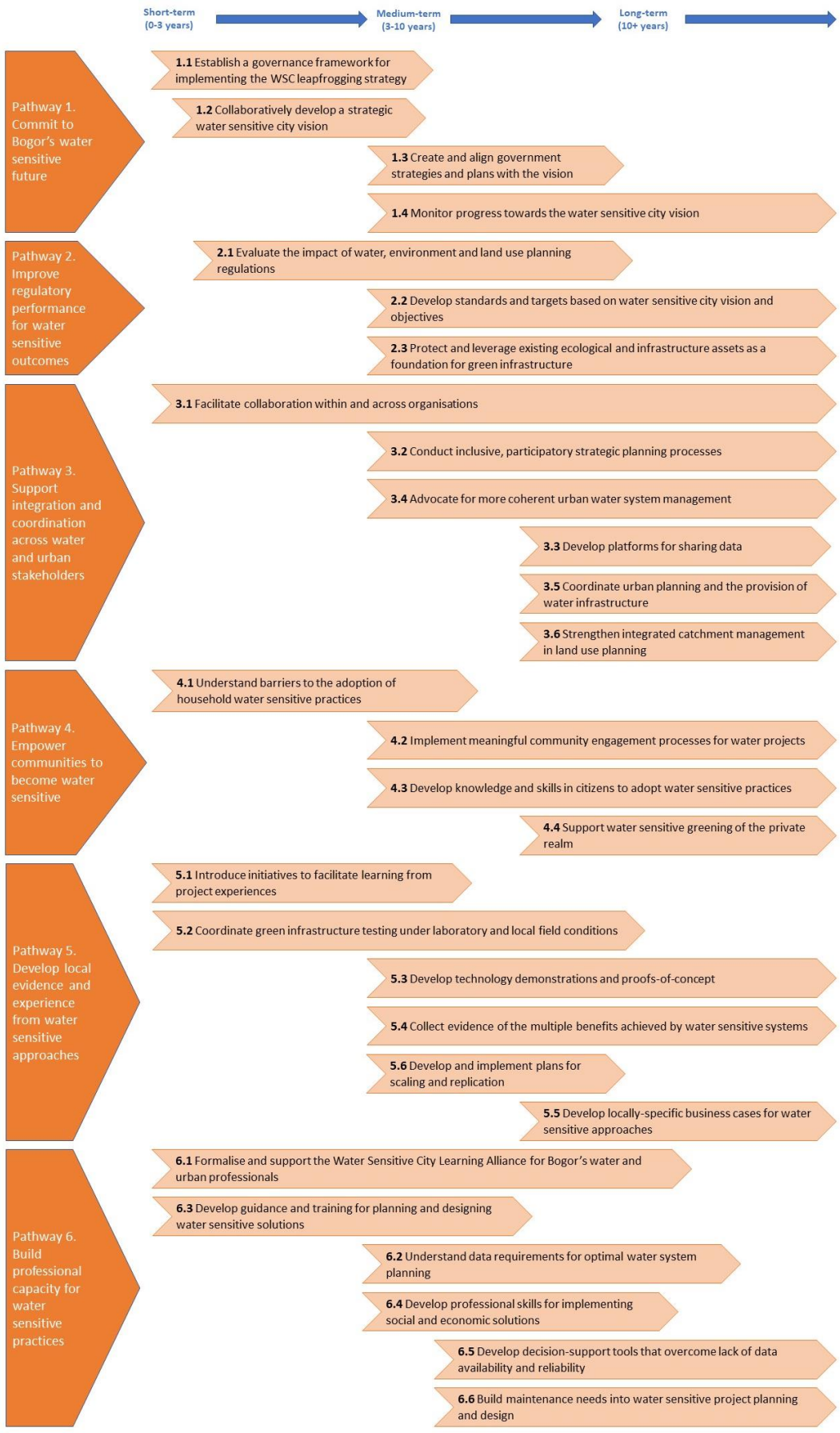


Figure 6. Small-scale urban consolidation leapfrogging strategy priorities

5.4. LEAPFROGGING WITH PRECINCT-SCALE MIXED-USE RENEWAL PROJECTS

Large urban sites slated for substantial redevelopment with proposals for both residential and commercial buildings may involve a range of existing land uses, from former industrial sites to small lot agriculture and low density residential. New development typically requires complex land consolidation and detailed masterplans to integrate the proposed new precinct into the existing urban framework. Examples of these developments are Kebon Melati, a 4 ha site in Jakarta near Melati Reservoir, Daan Mogot City, a 16 ha site in West Jakarta, and Millennium Village, a 70 ha mixed use site in Karawaci, Tangerang.

This form of development is increasingly promoted throughout the western world and is frequently associated with developing neighbourhoods with a range of housing types, and that are close to services, jobs and transport options. It is promoted by national policy for land consolidation of private, state-owned land and abandoned land for more efficient residential development in urban areas (RPJMN 2015-19). Jakarta in particular has in recent years identified the need for increased construction of vertical housing in accordance with the carrying capacity of the local environment and implemented through synergies between the government, business and the community (RPJMD DKI Jakarta 2013-2017).

This development scenario is informed by learnings from the Situ Front City case study, located in the city of Cibinong in Bogor Regency. Cibinong is the seat of government for Bogor Regency and one of the more densely populated districts in the municipality (BPS-Statistics Bogor Regency, 2017). Situ Front City is a relatively large development site centred on situ Cikaret and Bentenan; the site accounts for 5% of the district's land area, and its realisation will add significantly to the district's current population of 412,156 people as well as tourist accommodation and jobs. The primary proponent of the development due to commence in 2018-19 is the municipal government.

The development differs from traditional practice in Indonesia in the prominence afforded to water in the design for aesthetic, recreational and ecological purposes. Mainstream practice has resulted in the loss of many situ in the region by reclamation for development.

Current use of the site includes waterways, agriculture (mainly rice), government office, commercial and residential. Redevelopment will require relocation of existing communities, and the masterplan allocates social housing to support relocation. Managing existing and new drainage issues is a key concern for the future resilience and liveability of the site. This project proposed amendments to the Situ Front City Masterplan that, in addition to the situ forming the centrepiece of the precinct, facilitate the appropriate siting of several other water sensitive urban design assets, such as bio-filters, water retention ponds, wetlands, and raingardens. The proposed revisions compensated for a lack of spatial information for the precinct with land use modelling that permitted use of green technology siting tool.

Figure 7 shows the desirable rollout of leapfrogging strategies for large-scale mixed use urban renewal precincts such as Situ Front City. Development scenarios like this often require tailored masterplanning and because of their status have the potential to attract exceptional regulations, which brings attention to the capabilities of existing regulations (strategy 2.1). In these cases, there is also a need to have strong, enforceable protections for existing ecological assets to facilitate their sustainable integration into development proposals (strategy 2.3) and to develop standards and targets that that such developments need to meet to achieve their aspirations (strategy 2.2).

The scope of Situ Front City-type developments, such as the integration of residential and employment land and potential to produce significant environmental impacts warrants focusing on enabling greater inter-organisational collaboration and information sharing (strategies 3.1 and 3.3). Additionally, even if the development proposal does not concern a current residential area, the development scale will often impact residents of neighbouring areas. This should drive commitment to inclusive and participatory planning processes and community engagement to reinforce the value of water sensitive solutions (strategies 3.2 and 4.2).

To position planners to make effective contributions to masterplanning, it will be important to better understand the data requirements for water system planning (strategy 6.2) and provide guidance for planning and designing water sensitive solutions (strategy 6.3). Though it may not be a priority for small-scale development, at the precinct scale there is value in considering the long-term maintenance requirements of green technology solutions (strategy 6.6). Another priority enabler in this scenario is to formalise the WSC Learning Alliance (strategy 6.1).

Considerable work should go into developing local evidence and experience from water sensitive approaches within these high-profile developments. There is value in the short-term from pursuing strategies related to clarifying the value of potential green technology solutions (strategy 5.2), developing technology demonstrations (strategy 5.3) to support masterplanning, and then learning from planning experiences (strategy 5.1). In the longer-term, these prominent cases can also produce valuable evidence to promote broader dissemination (strategy 5.4).

Figure 7. Leapfrogging strategies precinct-scale mixed-use renewal

5.5. LEAPFROGGING IN GREENFIELD URBAN EXPANSION

Between 2000 and 2010, the amount of land in urban areas in Indonesia increased 1,100 km^2, which was the second largest increase in urban extent in the East Asia region, after China. However, Indonesian cities have been absorbing far higher populations than this urban expansion suggests, with a significantly increasing urban density and the lowest proportion of new urban area per new inhabitant in the region (The World Bank, 2015). This situation may have arisen from a shortage of infrastructure construction to support urban expansion. If this constraint is addressed over the next ten years, the rate of urban expansion will likely increase.

Expansion at the boundaries of existing urban areas can provide a range of housing options and more affordable land for services to support growth, like schools, green open space and essential services. The metropolitan area of Jakarta has been expanding in municipalities at the periphery, particularly Tangerang Regency, Bekasi Regency and Bogor Regency. Of municipalities in Greater Jakarta, Bogor Regency experienced the highest population growth in the early 2000s, a significant proportion of which settled in new urban areas.

One of these areas, Sentul City, was the subject of one of the project case studies. Sentul City is a 3,100 hectare region located in *Kecamatan* Babakan Madang, Bogore Regency, 10 km from the centre of Bogor City (https://www.sentulcity.co.id/v01/abouts/about-sentul-city). It is accessible via the Jagorawi Toll Road from Jakarta.

Before development began in the 1990s, the area was used for agriculture and plantation forestry. It is now home to 8,000 permanent residents and over 1,000 temporary residents who use Sentul City as a weekend retreat or for short-term tourist accommodation. The Development Plan anticipates a further 200 hectares of residential development to 2025 in addition to the 260 hectares of residential development to 2018 (http://sentulcityindonesia.blogspot.com/p/future-development.html).

Residents of Sentul City are supplied with water produced by the municipal water supply company, PDAM Tirta Kahuripan, although distribution within the estate is the responsibility of land owner groups. Dry season water shortages remain common. Development of a diversity of affordable water supply options is considered necessary, particularly as residents are prohibited from digging bores to access groundwater.

Stormwater management is also an issue for the area, as typical soils are unstable, prone to erosion and unsuited to infiltration. High rainfall creates large volumes of stormwater runoff. In addition to this, household wastewater is managed with onsite septic systems and treated effluent is difficult to drain onsite. These issues suggest clear opportunities for green technology such as onsite rainwater harvesting, biofilters, raingardens, the opportunity to add to existing blue assets such as retention ponds, and decentralised water management.

Challenges for the implementation of water sensitive solutions include a lack of experience among professionals with the large-scale rollout of green technology, low home-owner agency through lack of access to information and decision-making power, and deficiencies in the regulations for household waste.

Figure 8 shows the desirable rollout of leapfrogging strategies for greenfield urban expansion projects. As with large-scale mixed-use precincts, these scenarios often have a high profile and their scale warrants attention to protections for existing ecological assets (strategy 2.3) and the need to understand the impacts of existing regulation as well as what new standards will support sustainable development (strategies 2.1 and 2.2).

Given the potential for environmental and social impacts from these developments both in the short-term from development of greenfield land and in the long-term from an accessibility perspective, urban expansion scenarios should consider focusing on enabling greater inter-organisational collaboration (strategy 3.1) and commitment to inclusive and participatory planning processes (strategy 3.2).

Considerable work should go into developing local evidence and experience from water sensitive approaches within these high-profile developments. The testing of green technology solutions for anticipated applications and conditions (strategy 5.2), developing technology demonstrations (strategy 5.3) to support masterplanning, and then learning from planning experiences (strategy 5.1) are all important short-term leapfrogging strategies for greenfield urban expansion. To position planners to make effective contributions to masterplanning, it will be important to better understand the data requirements for water system planning (strategy 6.2) and provide guidance for planning and designing water sensitive solutions (strategy 6.3). In the longer-term, these prominent cases can also produce valuable evidence to promote broader dissemination (strategies 5.4 and 5.5).

To support cohesive planning at the urban boundary, a priority enabler in this scenario is to formalise the WSC Learning Alliance (strategy 6.1). This can contribute to enabling system management and catchment-based changes (strategies 3.4 and 3.6).

Communities at the urban fringes are emergent and so typically challenging to define and engage. A focus on effective planning can replace short-term imperatives for community engagement about water sensitive practices, resulting in strategies in Pathway 4 (Empower communities to become water sensitive) being suitable for shifting into the medium-to-longer term.

Figure 8. Leapfrogging strategies for greenfield urban expansion

Chapter 6

Conclusion

6. CONCLUSION

6.1. KEY MESSAGES FROM THE STRATEGIES

Leapfrogging involves countries adopting cutting-edge approaches without implementing the intermediate approaches that were part of the development trajectory of countries that were among the earliest to industrialise. Leapfrogging to a WSC may help Bogor achieve desirable water servicing outcomes with water sensitive principles and technologies without matching the cumulative infrastructure investment that developed countries have directed to water systems, as well as avoid the unsustainable features of water servicing models seen in developed countries.

The Urban Water Cluster has assessed Greater Bogor's current water system through the WSC framework and identified 29 strategies to facilitate its WSC transition through leapfrogging. This has produced forward-thinking strategies whereby key water issues identified through the research are sought to be addressed with long-term sustainability as a priority.

These 29 strategies are organised into six leapfrogging pathways based on commonalities of intervention emphasis, such as leadership and governance, regulation, organisational collaboration, community-driven action, learning processes, and practitioner skills. This multi-targeted approach recognises the complexity of water systems in general and Bogor's challenges in particular. Coordinated strategic action along each of the pathways allows for an integrated, holistic and mutually reinforcing pursuit of Greater Bogor's water sensitive aspirations.

There are six key messages that the Urban Water Cluster wishes to emphasise with these recommended strategies:

Catchment planning

Although there are some structures in place for catchment governance, it is important to improve collaboration between governments for a broader array of management issues, for example in regulatory alignment and sharing data to support land use planning. It is important that there be stronger vertical alignment across government scales towards catchment objectives.

Broad collaboration

Multi-sectoral integration has potential for significant expansion in Greater Bogor, for example by integrating water sensitive applications into a wider array of urban infrastructure and services (e.g. urban farming, mitigation of the urban heat island effect). This could begin with focusing on developing a regional water sensitive vision, broadening community engagement and participation, and formalising a Learning Alliance of diverse stakeholders. Sectoral integration may also be promoted by collecting evidence of a variety of benefits of water sensitive systems

Knowledge

This research revealed systemic gaps in knowledge and data that have the potential to hold back the deployment of water sensitive technologies and innovations. Going forward, it will be important to create confidence in the potential of green infrastructure to address Greater Bogor's needs through suitable testing and by addressing gaps in biophysical data to enable their appropriate application.

Regulation and policy

The implementation of regulation to support water sensitive objectives was a significant area of concern for many stakeholders. It is important to collect more information about the strengths and limitations of existing regulation in delivering these objectives, as well as increase the capacity of governments to develop effective non-regulatory policies to achieve desirable outcomes.

Household practices

The impact of community behaviours on current system conditions includes aquifer depletion and pollution and delaying adoption of safer and more reliable collective supply and treatment options. The importance of educating citizens about these impacts is recognised by stakeholders, but system-wide changes in how the community is engaged with are recommended. These include increased investment in broader participatory platforms and setting a regional water sensitive vision that aligns and focuses activities aimed at developing water stewardship practices amongst households and communities.

Implementation timeframe

The timeframe for implementing change is an overarching consideration. Timeframes of socio-technical transitions are typically in the order of decades, although this potentially can be reduced with dedicated pursuit of leapfrogging. The political climate in Indonesia favours rapid transitions for improved human development, but this typically obscures the deep-seated and systemic challenges required to be overcome. The timeframe chosen for the long-term, 10-20 year strategies recommended here are feasible, but this is largely dependent on substantial reorientation of stakeholders towards WSC objectives taking place in the short-term.

6.2. NEXT STEPS FOR CONSIDERATION BY LOCAL ACTORS IN BOGOR

While the leapfrogging pathways are intended to be rolled out in parallel, within pathways there are suggestions over the staging of implementation for the short- (i.e., 0-3 years) to the long-term (i.e., further than 10 years). This staging is designed to accommodate the presence of dependencies between strategies as well as some immediate limitations on the feasibility of implementation.

Priorities for on-ground action include learning from previous experiences as well as creating opportunities for new learning from laboratory testing and field demonstrations of water sensitive technologies (Strategies 5.1-5.3). This can be pursued through augmenting and a limited refocusing of existing research activities of key organisations. Greater understanding of data requirements for optimal water

system planning (Strategy 6.2) and of the barriers for households to adopt water sensitive practices (Strategy 4.1) will improve the effectiveness of policy implementation at different scales. This needs new programs by local government and will likely require lobbying of central and provincial governments for new funding. Processes for inclusive and participatory strategic planning (Strategy 3.3) and meaningful community engagement (Strategy 4.2) are also important foundations of sustained support for the water sensitive agenda in Greater Bogor. There are existing governance processes that support these strategies, but the recommendations may require governments to show considerable leadership and innovative engagement to extend the scope of these processes to new, previously underrepresented, participants.

Collaborative regional governance should be a key focus of the next steps for Greater Bogor water sensitive transition. It is recommended that the momentum of this Urban Water Cluster research be built upon to immediately establish a governance framework for implementing this WSC leapfrogging strategy (Strategy 1.1). Key agencies and institutions should contribute to this framework, which would become an important driver of collaboration within and across organisations (Strategy 3.2). The first significant output of this coalition could be the sponsorship of a strategic water sensitive city vision for Greater Bogor to be developed with contributions from diverse government, industry, community and research stakeholders (Strategy 1.2). A WSC Learning Alliance (Strategy 6.1), which has been established as part of this research to build capacity to adopt water sensitive practices amongst Bogor's water and urban professionals, should be embedded into longer-term planning by key organisations.

6.3. INSIGHTS FOR WSC LEAPFROGGING IN OTHER INDONESIAN CITIES

The pattern of urban development and water servicing studied in Bogor has also been observed in other Indonesian cities (Asian Development Bank, 2016a). Urban flooding and dry-season water shortages are common; over half of Java's population was estimated to be living in areas highly affected by water insecurity, suffering from droughts and floods (Deltares, DHV, MLD and Wiratman, 2012). The low coverage of urban water supply companies is causing over-exploitation of deep groundwater in most urbanised areas, leading to aquifer depletion and land subsidence in some areas. There is therefore the need to substitute groundwater use in most large cities of Java (Deltares, DHV, MLD and Wiratman, 2012).

In the urban areas of Indonesia, only about 1% of the wastewater is safely collected and treated, and about 4% of the sewage is safely collected and safely disposed or treated (Asian Development Bank, 2016a). Human resource capacity within the agencies responsible for the sanitation sector has been found to be extremely limited at all levels, which is a key constraint to the further development of the sector throughout Indonesia (Kearton et al., 2013). The technical challenges to constructing sanitation systems seen in case studies such as Pulo Geulis in Bogor City are not uncommon in Indonesia, with many large cities characterised by low-lying topography, adjacent major rivers, high water tables, narrow streets and high traffic

volumes. Combined, this serves to make sanitation system construction challenging in many urban areas (Kearton et al., 2013).

The UWC conducted a review of the available information to provide broad recommendations for the selection and application of green infrastructure in Indonesia for the management of urban stormwater and domestic greywater. Therefore, the recommendations made in this report relating to green infrastructure and target-setting (and further detailed in the report, ***Review of the application of green infrastructure for water management in Bogor***) are considered to have broad applicability to Indonesia.

Catchment management in Indonesia has for many years suffered from a regulatory framework that is fragmented and has gaps, and this was further challenged following the successful constitutional challenge to the 2004 law on water resources. Bogor is not alone in requiring dedicated effort to promote capacity development among professional staff of organisations responsible for catchment management (Asian Development Bank, 2016b).

Urban governance is also fragmented in many areas of Indonesia. Like Bogor, there are numerous other cases of metropolitan conglomerations spanning a City government (*Kota*) as well as parts of neighbouring Regencies (*Kabupaten*). These include Bandung, Bekasi, Sukabumi, Cirebon, Semarang, Surabaya and Medan. Increased collaboration by municipalities and water utilities (PDAM) is crucial to supporting the capacity-building and network augmentation needed to meet water demand and to manage environmental issues associated with shared systems such as rivers and aquifers. It is considered that the WSC approach and Learning Alliance framework can be transferred to other large urban areas in Indonesia.

6.4. FURTHER RESEARCH

Further research is suggested for Bogor specifically and Indonesian water sensitive cities more generally. For example, barriers to household adoption of water sensitive practices (Strategy 4.2), data requirements for system planning (Strategy 6.2), project learnings (Strategy 5.1) and green infrastructure testing (Strategy 5.2).

While beyond the scope of work by the Urban Water Cluster, some broad comments can be made about how Indonesian cities more generally may facilitate water sensitive cities. First, it appears to be the case that modelling of climate change scenarios for Indonesian regions has so far been under-resourced, but would help refine effective adaptation pathways, which can be used to tailor infrastructure investment decision-making in the short-term.

Second, given the need for accurate local data to support appropriate system design, the potential for recruitment of citizens to collect data would benefit from further investigation. Community are often recruited for environmental projects, for example groundwater infiltration, but to date the community's capacity to support citizen science activities is relatively untapped, although promising given low labour costs and the implications for community education.

Third, there is a need to investigate the potential for using rainwater more widely for network water substitution and food production in the urban environment. Little research has been performed on rainwater toxicity in Indonesian cities, and the potential for accumulation of toxins in rainwater tanks or food crops is not well understood.

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