Conclusions

Cities around the world have to become more resilient to climate change and reduce their ecological footprints. Green Cities are concerned with how to design the whole city in a more sustainable, efficient, adaptive and resilient way. They recognise connections between different sectors and support development strategies that fulfil multiple functions and create numerous environmental, economic and social benefits. Moving this concept on a stage further, Blue-Green Cities use a variety of natural and man-made water features to manage water, wastewater and stormwater to ensure that their populations are resilient to extreme weather events while at the same time ensuring the health of aquatic ecosystems.

Traditionally, urban water managers have relied on grey infrastructural solutions to mitigate risks. However, this has led to numerous economic and environmental consequences, including increased downstream flooding risks and CSOs impacting the health of aquatic systems as well as drinking water quality. In addition, traditional stormwater systems are unable to cope with sudden large volumes of precipitation that are expected to increase in frequency with climate change. Furthermore, rapid urbanisation, as well as increasing environmental regulations, is challenging cities to simultaneously manage floods while also restoring the health of waterways. As such, cities are turning towards BGI to enhance nature's ecosystem services in the management of water resources while increasing resilience to climatic risks. In addition, BGI solutions also provide multiple environmental, economic and social benefits.

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Urban water managers are increasingly employing an adaptive management decision-making framework that guides the planning, designing, implementing and monitoring of BGI. In the planning stage of adaptive management, cities develop an overall vision of implementing BGI and identify the geospatial extent of applications across the city. Collaborative partnerships are established between public agencies as well as between the public and private sectors. The multifunctional benefits provided by existing BGI, as well as local issues and challenges, are identified to ensure successful implementation. Finally, resources are allocated to ensure the successful and sustainable implementation and long-term management of BGI. In the design stage, cities need to communicate the strategy, plan or overall design and ensure BGI is functional and durable, in addition to providing other various benefits. During the implementation stage, cities set standards to ensure that BGI functions well according to locally relevant criteria as well as ensure adequate funding and resources are available for the ongoing management and maintenance of BGI. Finally, in the managing and monitoring phase, cities monitor the delivery of BGI against the established objectives and ensure that BGI features throughout the city are functioning well.

In the implementation stage, cities can encourage BGI on both public and private properties, by using a variety of fiscal tools. Common fiscal tools include stormwater fees and rates that not only encourage sites to reduce runoff but also provide a funding mechanism for cities to cover the costs of implementing BGI. Cities also provide various stormwater fee discounts that provide the owners of all types of property with the opportunity to reduce their bills by implementing a variety of BGI measures. To encourage the incorporation of BGI in new developments, cities often provide financial incentives that include green roof subsidies and construction grants. Finally, cities offer rebates to properties that apply BGI retrofits such as installing rain barrels and developing rain gardens.

To further encourage the development of BGI on public and private properties, cities employ a variety of non-fiscal tools, such as information and publicity campaigns to raise awareness not only of the potential financial savings of BGI but also the numerous environmental and social benefits it brings. To encourage developments to manage stormwater runoff on-site, cities offer fast-track reviews of projects that include BGI, which can result in financial savings for site projects. Many cities implement pilot and demonstration projects to allow residents to experience the benefits of BGI first-hand while garnering public support for large-scale

implementation. To ensure that BGI is implemented effectively, cities commonly develop performance standards. Other tools to encourage the implementation of BGI include awards and recognition programmes for BGI projects initiated by public and private sector actors, which encourage others to follow suit, as well as public education and awareness initiatives that aim to encourage residents to become stewards of the local BGI system.

Using the adaptive management framework stages of planning, designing, implementing and monitoring of BGI, the following best practices from the case studies of Copenhagen, New York City, Philadelphia, Rotterdam, Singapore and Washington D.C. have been identified for other cities around the world attempting to become Blue-Green Cities.

Many cities face fiscal constraints in implementing large-scale, city-wide BGI measures to reduce stormwater flow and improve water quality. A potential solution is to divide them into catchment or priority areas, allowing the process of implementation to be staggered. By identifying priority areas, cities can saturate them with BGI, while achieving cost-savings from efficiencies in design and construction.

Cities commonly integrate BGI with other capital projects to capitalise on economic efficiencies. This is cost-effective when the projects are implemented in places where construction has already begun, such as urban renewal projects and infrastructure upgrades. To ensure these BGI projects function well, guidelines have been prepared on how best to integrate BGI in public projects as well as restore them if utilities are performing work in and around BGI.

Because BGI is multifunctional, implementation requires interagency cooperation, whether it be between the city and the utility that manages its stormwater system or between the various departments and agencies. This is also important when applying BGI measures to specific areas in the city. To achieve efficiencies, city agencies can cooperate on the bidding of BGI contracts as well as form partnerships in developing BGI on public properties such as school playgrounds and housing developments. MOUs can be created that set out the expectations on where BGI projects will be located, how they are designed and constructed, how outreach is performed and how they are maintained. Cooperation is required between the public and private sectors when seeking to expand a BGI programme across the city, with the need to ensure that BGI installed in private developments is properly designed and effectively maintained. One city has implemented an accreditation programme for BGI professionals to

ensure there is an adequately trained workforce for the widespread implementation of good quality BGI projects.

To encourage the management of stormwater on-site, several cities have introduced stormwater fees, determined by the impervious surface area of the property. For commercial and other large properties, the fee is often based on the actual impervious area, while residential properties pay a standard amount based on the average surface area of homes in that city. One city is even trialling a pilot stormwater parking lot fee to encourage the reduction of stormwater runoff to its wastewater system.

To reduce stormwater bills and encourage the implementation of BGI on properties, cities have developed a range of subsidies and grants. For instance, stormwater grant programmes can fund the design, construction and maintenance of BGI on private property. Other grants are distributed to homeowners who, after attending BGI workshops, determine which tools are most cost-effective, with a city-appointed contractor installing the BGI. Alternatively, the city offers a subsidised inspection of the homeowner's property to determine the best BGI solutions to manage stormwater on-site. Other cities offer subsidies for the installation of green roofs on both public and private properties.

Cities often provide funding for owners of non-residential property looking to design and construct BGI retrofits. The funding is dependent on total volume of runoff managed, cost-competitiveness as well as the potential environmental and educational benefits derived from installing BGI on large parcels of land. Similarly, one city offers an incentive scheme that funds a portion of the installation costs of BGI on both residential and non-residential properties. It offers funding to companies implementing BGI across multiple properties. To inspire innovation in BGI designs, another city has developed a stormwater retention credit trading scheme that allows companies to buy and sell stormwater credits to meet or exceed their regulatory requirements.

Several cities mandate the implementation of BGI in new developments on both public and private land. An example is one city requiring green roofs be installed on new developments to adapt to climate change, enhance biodiversity and green the city. Another encourages developers to go beyond meeting minimum BGI standards on new developments by offering a fast-track review process of the design if it manages nearly all its stormwater onsite.

Where BGI is mandatory, cities have developed stormwater performance standards for new developments or major site expansions, as well

as guidelines that detail best management practices for meeting the cities' requirements. Similarly, green streets design manuals provide BGI design details and specifications for both public and private entities implementing BGI in rights of way.

To ensure BGI is effective and maintained well, cities often require mandatory BGI be approved by their respective city agencies in charge of stormwater management. Meanwhile, one city requires BGI design and construction processes be overseen by a registered BGI professional.

Many cities have initiated stakeholder engagement programmes to encourage residents to contribute to the design of public BGI, develop community-led BGI projects, adopt BGI features in their neighbourhoods as well as implement BGI on their own properties. Examples include: (1) a city inviting residents to suggest how BGI projects located in their neighbourhood should look and what additional activities can be included in the project; (2) a city agency holding town hall meetings to educate the residents about BGI and the construction impacts over the duration of construction; (3) a city seeking partnerships with community stakeholders across the city to develop BGI projects with a dedicated website created for the community to learn about BGI project requirements and funding opportunities; and (4) a programme that provides grants to civic organisations to help maintain the beauty and functionality of BGI across the city's neighbourhoods.

To further enhance public awareness of BGI, cities have implemented a variety of online and offline public education and outreach programmes. Examples include: (1) a map that enables the public to search for BGI projects throughout the city; (2) a YouTube video that describes the environmental challenges of CSOs and BGI measures to reduce stormwater runoff; and (3) a smartphone app that enables users to explore the multifunctional BGI measures required to become climate-proof. Offline, cities have implemented traditional public outreach campaigns on BGI including city representatives attending neighbourhood meetings, distributing flyers and mailers and attending community festivals.

To enhance knowledge of BGI among developers, planners and other professionals, cities can develop a range of online interactive tools that link BGI with climate adaptation and other benefits. For example, one city has developed an interactive climate atlas that provides visual impacts of climate change as well as a climate adaptation toolbox to understand potential adaptation measures at various spatial levels. In addition, it has developed a computer program that visualises the effects of implementing

BGI measures in urban spaces. To enhance awareness on the multiple benefits of BGI, it has developed a societal cost–benefit analysis tool that shows how BGI measures incorporated with other projects or programmes can provide positive cost–benefit outcomes. To enhance awareness of the significant amount of cooperation required between public agencies as well as between the public and private sectors to implement an effective BGI strategy, the city has also developed a computer climate game that teaches players how to allocate roles and get everyone to work together to implement adaptation measures.

To enhance practical knowledge of BGI, a couple of cities have initiated public workshops for residents to understand how it works and how it can be maintained. Examples of workshops include one on bioswales and another on rainwater harvesting.

Cities have initiated a variety of programmes to promote the public recognition of BGI projects as well as of the professionals implementing them, including: (1) excellence awards to celebrate BGI projects that provide multiple triple bottom line benefits; (2) a certification scheme to recognise public agencies and private developers who incorporate BGI features in their developments, and (3) the development of a registry for accredited BGI professionals.

Cities have launched challenges to drive private sector innovation in the development of BGI. Examples include solutions that reduce the cost of installing BGI, as well as new approaches in both public and private spaces that both raise awareness and accelerate implementation.

Several cities run education programmes to introduce students to the benefits of BGI and the measures used to manage stormwater runoff. The format varies from school visits to teaching courses that both educate students in a classroom setting and also provide practical experience on how BGI works and how it can be maintained.

Cities are aware that implementing BGI can be a driver for growing green jobs. One city will ensure that at least half of all new jobs created by BGI projects will be filled by local residents. To achieve this goal, it has launched an apprenticeship-style training programme for young adults to work in BGI. In addition, it runs a mentor-internship programme in which projects of a specific value performing a variety of BGI-related tasks will take in interns.

In the context of the adaptive management framework, cities implement a variety of monitoring strategies at both the strategic and operational level to manage their path towards becoming Blue-Green Cities. For

instance, at the strategic level one city has developed a climate adaptation barometer that tracks its overall progress towards adapting to climate change. Another city is developing a GIS-based project tracking and asset management system for its BGI assets. Similarly, a third city measures how BGI projects increase the quality of life in neighbourhoods located using an urban life account.

At the operational level cities implement a variety of strategies to monitor the performance of BGI. For example, one city has standardised its BGI designs and procedures to ensure it can measure progress towards reducing CSOs in specific priority areas. Another city is constructing BGI in a sequential fashion, enabling it to monitor and assess the performance of installed BGI as the programme is rolled out, ensuring the BGI projects are practical and effective for CSO control while providing numerous benefits to the community. Similarly, another city agency holds monthly meetings on the status of BGI projects in addition to monthly BGI maintenance meetings.

In conclusion, becoming a Blue-Green City is not a static goal; instead it requires an adaptive management framework that involves planning, designing, implementing and monitoring of both the design and implementation of BGI. To encourage city-wide implementation of BGI, cities also need to develop a range of fiscal and non-fiscal tools to encourage the implementation of BGI on both public and private land.

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