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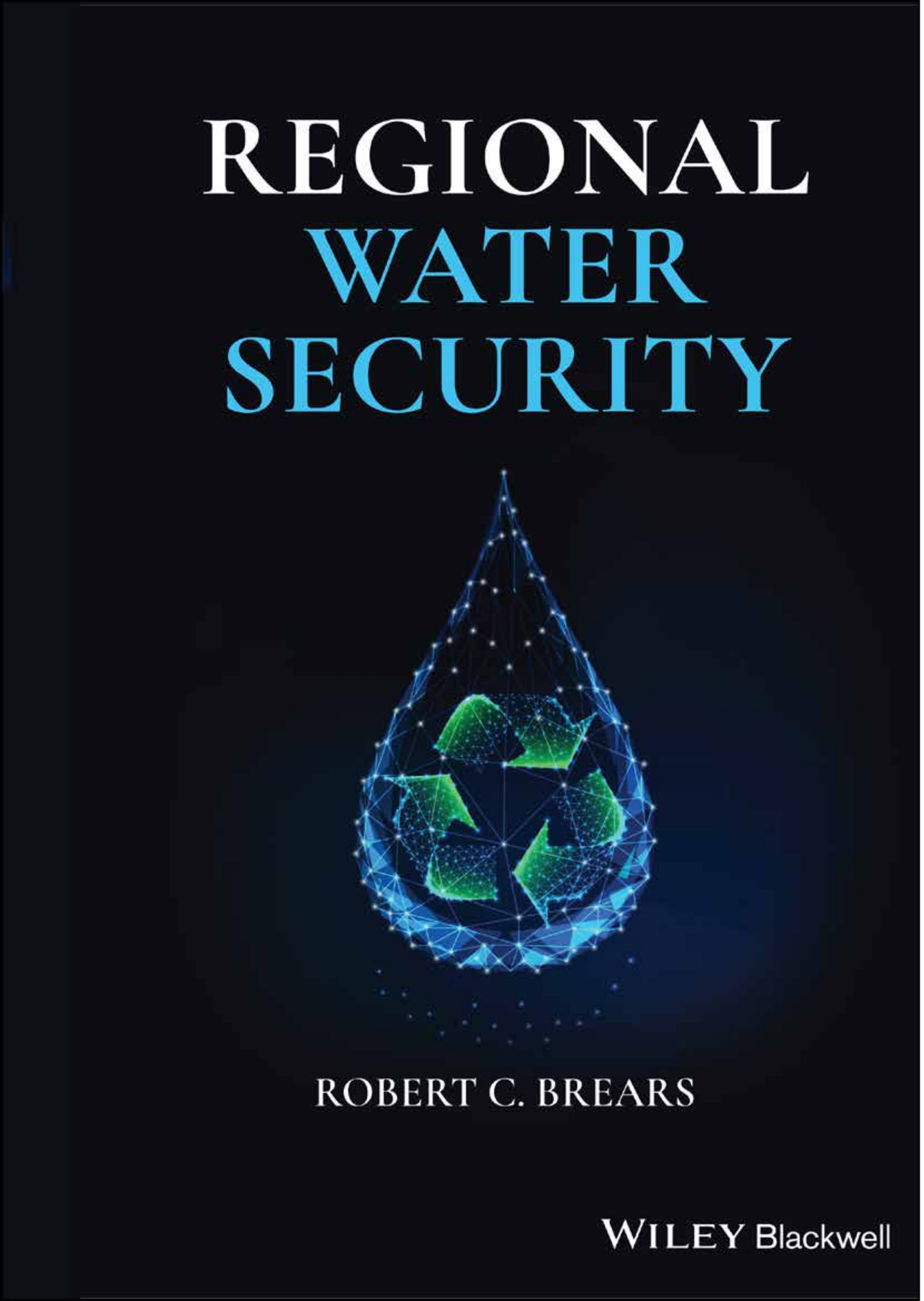
Mark and Focus

Building a Smart, Resilient, Nature-Based Future



Mark and Focus

Mark and Focus covers both the risks and opportunities the world's mega-trends provide.

INTRODUCTION

In the 21st Century, the world faces a wide array of mega-trends including climate change and rapid population and economic growth. With resources becoming scarce global economic and social stability is threatened.

Mark and Focus covers both the risks and opportunities these mega-trends provide to business, governance, and society.

*Disclaimer: The following views and opinions expressed in this publication are those of the authors. They do not purport to reflect the opinions or views of Mark and Focus.

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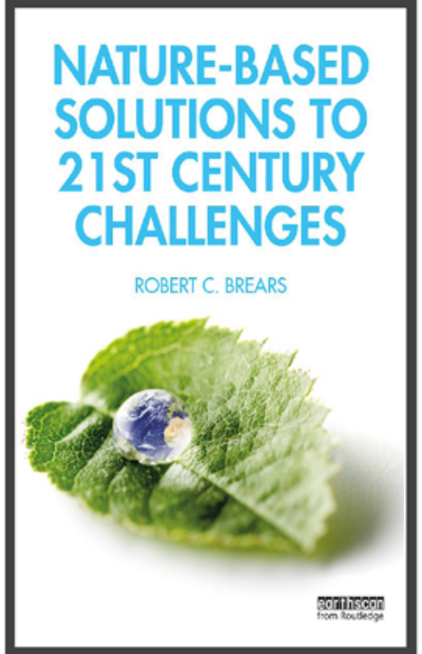

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Nature-Based Solutions to 21st Century Challenges

Robert C. Brears

This book provides a systematic review of nature-based solutions and their potential to address current environmental challenges. This book systematically reviews nature-based solutions from a public policy angle, assessing policy developments which encourage the implementation of nature-based solutions to address societal challenges while simultaneously providing human well-being and biodiversity benefits. It will be of great interest to policymakers, practitioners and researchers involved in nature-based solutions, sustainable urban planning, environmental management and sustainable development generally.

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NATURE-BASED SOLUTIONS TO 21ST CENTURY CHALLENGES

ROBERT C. BREARS

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Cultivating Ecological Civilizations to Solve Our Growing Global Challenges

By Latoya Abulu

Project Manager, Joint US-China Cooperation on Clean Energy | Journalist

The term' ecological civilization' may seem new to many. Still, it is a concept that is rapidly gaining ground in environmental circles as it becomes the topic of the Convention on Biological Diversity's (CBD) 15th Conference of Parties to be held in Kunming, China, in October 2021. A Chinese concept that stipulates that human harmony with nature must be at the core of any civilizational development project and is a means that can offer solutions to social, economic, and environmental global challenges. It is a concept that is worth visiting ahead of the upcoming (CBD) conference titled: "Ecological civilization: Building a shared future for all life on earth."

There are two ways we can approach the idea of using the concept of ecological civilizations to grapple with and address current global issues. First, the idea of building or transitioning civilization states into ecological civilizations gives the opportunity of creating a fixed point and a map in which nations, states and civilization states can move towards when grappling with our environmental and climate issues. Instead of a jumbled list of policies to implement that may even be discordant, incongruent, and disorganized, and thus difficult to implement efficiently and successfully, ecological civilizations recognize the tie between civilization and environment in a holistic whole.

Through them, states can piece their social, economic, cultural, epistemological, moral, legal, political, technological, and agricultural systems together holistically and harmoniously towards environmental sustainability with life on earth as an underlining function. This maintains the sustainability and stability of their societies and cultures and addressing human well-being and advancement.

Further, the mandate of the ecological civilization does not simply propose a framework for society after the industrial revolution, but through its concept of the 'civilization', it withholds in itself the framework of development, advancement and complexities many developing nations require to lift many of their poverty-stricken and marginalized citizens at the bottom of society out of poverty and atrocity and towards a dignified state of humanity - where all can be part of the benefits of environmental sustainability. From this

perspective, the ecological civilization can give all states a clear and pinpointed direction and inspiration to go on together to address and adapt to environmental and climate crises, as well as address their material needs for sustainable development and safety.

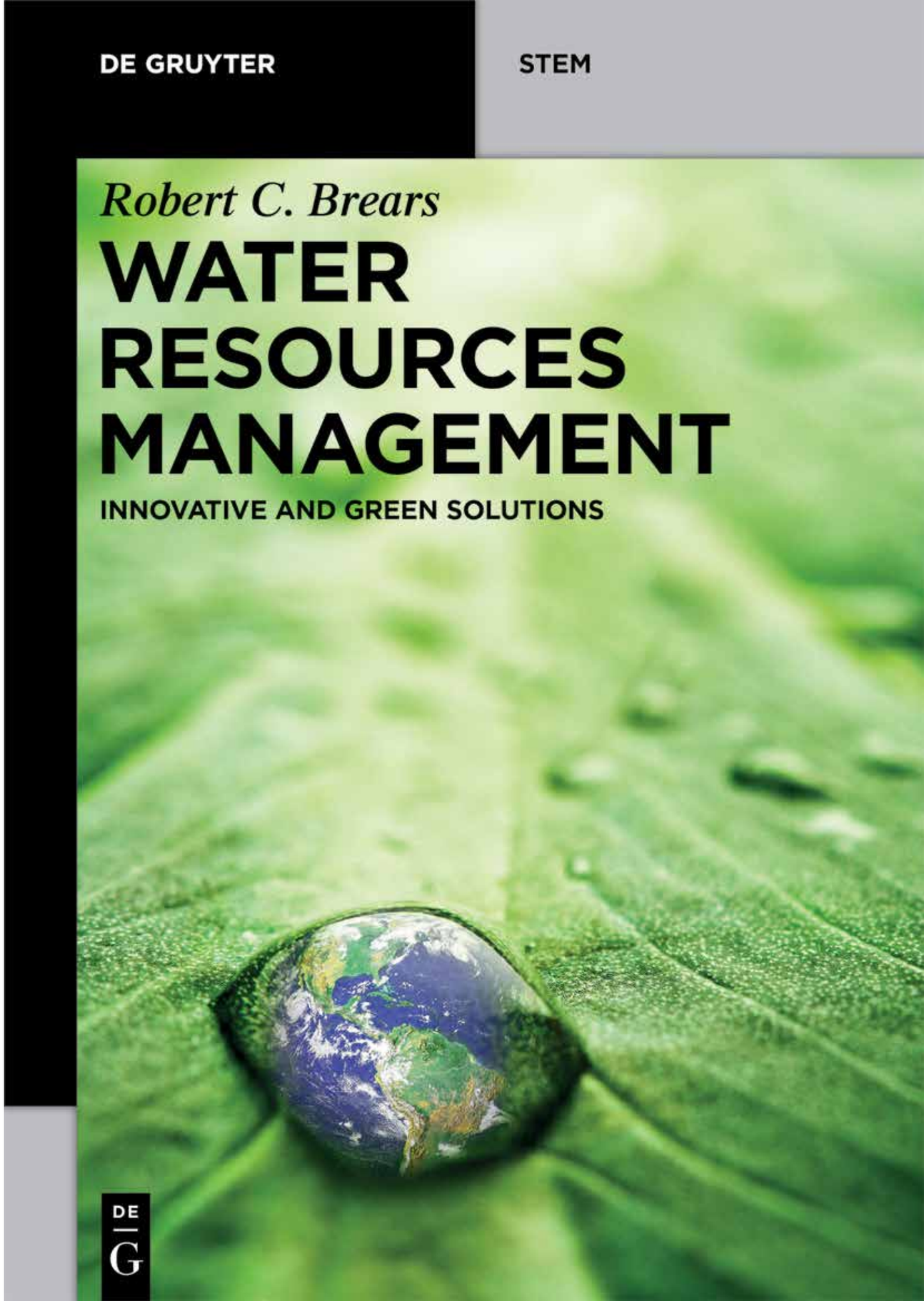
Second, the ecological civilization, influenced by Chinese philosophy, stresses humanity's flow and harmony with nature can serve as a blueprint for international human relations with each other in our emerging multipolar world and contemporary geopolitical conflicts. This harmony with nature is also a point stressed by scientists when stating in climate and biodiversity reports that our systems of thought and actions need to consider nature's limits, balances, and operations in our courses of development, food production, consumption, spatial planning, houses etc. This can be seen in the 4th Science Forum to the Plenary session of the 14th Conference of Parties to the Convention of Biological Diversity's report titled 'Towards living in Harmony with nature by 2050', highlighting the necessity of our societies and systems to be in harmony with nature's functions and developments, which is a core tenant of the 2050 Vision of Harmony with Nature to meet the post-2020 biodiversity targets.

The ecological civilization's concept of harmony with nature and a 'civilization state' that is anchored in its history and culture can bring humanity on a shared pathway of peace through emulating nature's harmony: the harmony of its multiple biodiverse ecosystems and climates with one another. As each ecological civilization is entrenched and in harmony with its own ecosystems and environments that the CBD underlines informs and influences its social, economic, cultural, historical, and political bases, the distinct ecological civilizations of the world should then be in harmony with one another as nature's ecosystems, biodiversity and climates are. As wisdom and science show, nature and the planet functions on the harmony and balance of its diversity. Our own international and political world could too. The pathway towards the ecological civilization, through its epithet of harmony with nature, can be an inspiration to put humans on the pathway towards international peace and harmony with each other and their own cultural diversity through the reality of our tensely emerging multipolar world and create the reassurance of cultural distinctiveness without conflict but, rather, mutual understanding.

There are additional possible benefits of the adoption of the concept of ecological civilization can bring to address current global and environmental challenges: The diversity and natural harmony of ecological civilizations helps societies and communities better retain the traditional and scientific knowledge of their localities and put them into practice, such as endemic seeds, crop diversity, agricultural practices, local balanced diets, and the protection of species. Increased sensitivity to the local environments of the ecological civilizations can inform better ecological management. It does not create a stale state of sameness but is one that preserves and celebrates the world's cultural and intellectual diversity. This diversity in knowledge also includes ideas and breakthroughs that can help other states build their ecological civilizations, such as through observing different indigenous nature-based solutions, agricultural insights, architectural and urban design ideas, water and species management techniques, environmental policy frameworks, green development, the creation of sustainable social relations etc.

The concept of creating multiple diverse and harmonious ecological civilizations through its harmony with nature's biological diversity can serve as a barrier to general imperialism, hegemony, and conflict with other states by emphasizing harmonious diversity and the sovereignty this entails - making this a possibly popular concept in our geopolitical world. It takes note of the global political changes in international relations and power and directs the world towards a harmonious and balanced future with one another. It takes note of domestic conflicts within states that are seeking to affirm and preserve their cultures, histories, and distinctiveness in our modern age by underlining the cultural aspect that builds states into civilizations without falling into a reactionary mindset of simply embracing the past. Perhaps building ecological civilizations can be used to address global challenges in our social, economic and, especially, environmental sphere. It can give humans a holistic conceptualization of how their societies and living environments are intertwined and create a discernible fixed point for achieving environmental sustainability, sustainable development, and addressing their society's needs.

Also, the ecological civilization's concept underlining humanity's harmony with nature can be extrapolated to inspire humans to mirror nature's harmony of its biological diversity and bring balance to the emerging conflict-ridden world by understanding our own cultural diversity and the importance of being harmonious and at peace with one another.



“It’s the Environment, Stupid”: Nature-based Solutions for Resilience and Sustainability

By Marcus Oxley

Director of Sustainability and Resilience. Climate Change, Sustainability and Resilience Practice.

AECOM Europe

As governments declare climate emergency and plan for COP 26, this February saw the release of the Dasgupta Review “The Economics of Biodiversity” commissioned by the UK government. The opening forward by David Attenborough is stark “We are facing a global crisis. We are totally dependent upon the natural world. But we are currently damaging it so profoundly that many natural systems are now on the verge of a breakdown. If we continue this damage, whole ecosystems will collapse. That is now a real risk.”

The risk to our societies is readily apparent when considering the steady rise in disaster losses, with projections of further losses due to increases in climate hazards and changing patterns of vulnerability and exposure. In our increasingly interconnected world, disaster risk is all-pervasive, with one crisis connected and influencing another in ways that are testing our resilience to the limit.

As global risk becomes systemic, there is a pressing need to manage risk using more holistic, integrated approaches. Linear patterns of economic development pollute the environment with greenhouse gasses that change the climate whilst simultaneously destroying ecosystems (that absorb pollutants and moderate hazards) faster than they can regenerate. Climate change, disasters and environmental degradation are inextricably linked and driven by unsustainable development. They cannot be addressed in isolation.

Despite these interdependencies, the UN post-2015 frameworks to deal with these challenges were negotiated separately and are not well aligned. The segmentation of global agendas cause duplication and overlaps that increase transaction costs and make little use of synergies to optimise impacts. Of the major international frameworks, the Paris climate agreement carries the greatest political weight. Climate action has been further separated into two strategies: mitigation to reduce sources or enhance sinks of greenhouse gases and adaptation to withstand climate change impacts. Climate mitigation has significantly larger resources for implementation and tends to subsume other agendas.

NATURE-BASED SOLUTIONS FOR RESILIENCE

Whilst reducing biodiversity loss is not possible without climate mitigation, achieving carbon neutrality will not fix the biodiversity crisis at the core of the Dasgupta Review. More integrated solutions across climate change, biodiversity, and disaster risk reduction (DRR) domains are needed to optimise primary and co-benefits. For example, the restoration of ecosystems is one of the most cost-effective means to mitigate climate change, with significant adaptation and DRR benefits. Siloed agendas that fail to maximise benefits inevitably means countries incur substantial opportunity costs when implementing policies. Going forward, the challenge lies in finding entry points and strategies for holistic approaches that strengthen coherence, unlock synergies, and allow resources to be used more effectively. Not surprisingly, given our total dependence on the natural world, nature-based solutions (NBS) have a vital role in strengthening resilience and sustainability. Nature-based solutions cover a spectrum of actions that work with nature's ecosystems to address societal challenges whilst providing environmental benefits. NBS are at the nexus of climate change, DRR, biodiversity and sustainability.

Although NBS was regarded as a mitigation action to absorb greenhouse gases, more recently, this has encompassed ecosystem-based climate adaptation and risk reduction. From a DRR perspective, the ability of natural systems to moderate hazards has long been recognised. Significantly, in addition to mitigation, adaptation and DRR benefits, NBS can reverse ecosystem degradation and strengthen biodiversity. Yet despite these co-benefits, only a fraction of climate investments support NBS approaches. Encouragingly, things are changing. There is a growing awareness of the potential of NBS, particularly the ability to integrate nature with physical infrastructure to simultaneously address societal and environmental challenges. Infrastructure is considered the foundation of a nation's development and is a critical interface between human and natural systems. More than other human endeavours, the built environment is one of the most significant single determinants of public, environmental, and planetary health. Combining natural systems (green infrastructure) with built structures (grey infrastructure) can provide stakeholders with more resilient, high-quality services in ways that meet development needs whilst supporting ecosystem regeneration. For example, the restoration of coastal green belts can increase carbon sequestration, absorb extreme hazards, regulate peak flows, reduce erosion mitigate flooding and increase biodiversity and amenity value.

Developing next-generation (integrated green-grey) infrastructure will require collaboration across sectors, scales, and relevant public and private actors. The global engineering consultancy AECOM, where I work, with a mission to "build a better world" and a strong commitment to environmental, social and governance (ESG) principles, is well-positioned to support this transition. Although more often associated with "grey" infrastructure, AECOM's multi-disciplinary workforce has extensive experience across the infrastructure project cycle and is building expertise and partnerships for nature-based solutions.

Not surprisingly, promoting NBS is not without challenges. Although there is evidence that NBS can achieve impressive results (e.g., China's Sponge City Programme), ecosystem-based actions take time to manifest and are often marginal when evaluated against narrowly defined project objectives. In reality, NBS investments come into their own when multiple benefits are taken into account over asset- rather than project-life timeframes. To date, there are very few standards, methods, tools, and technical guidance to support the appraisal, optimisation, and implementation of NBS measures that capture the monetary and qualitative aspects of co-benefits. Moreover, optimising NBS require landscape approaches to understand interdependencies and sources of resilience outside of the immediate project area. Although NBS projects can provide benefits for a wide range of stakeholders, investors will legitimately ask how much they are paying for someone else to benefit. Under current market conditions, only a fraction of NBS initiatives can be financed as purely commercial ventures. Like the climate discourse, optimising co-benefits requires considerations of differential responsibilities and mutuality, where conflicting priorities and economic disparities undercut cooperation.

Perhaps more than technical or financial solutions, the critical determinant to advancing NBS lies in governance arrangements. Government policies and legislation define the rules of the game. The growing body of climate legislation has been key to creating an enabling environment to reduce global carbon emissions. These need further work to provide the incentives that unlock synergies and combine green and grey infrastructure. There are signs countries are taking this path; New Zealand wellness-based policies announced in 2019 have recently been followed by a significant infrastructure upgrade designed to address social, economic and climate resilience challenges sustainably.

Closely linked to regulatory frameworks, NBS requires institutional structures that facilitate the inclusion and participation of state and non-state stakeholders. NBS approaches are more effective when implemented through cooperation with local people who have a strong appreciation of local ecosystem services' intrinsic value and benefits.

As experience tells us, "in the midst of every crisis lies great opportunity". In an unprecedented global environmental crisis, an opportunity lies in using the climate emergency to unlock synergies and accelerate a shift towards next-generation infrastructure that restores our relationship with nature, and in so doing, one other.

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NOTE: This paper gives the views of the author, and not necessarily the position of AECOM

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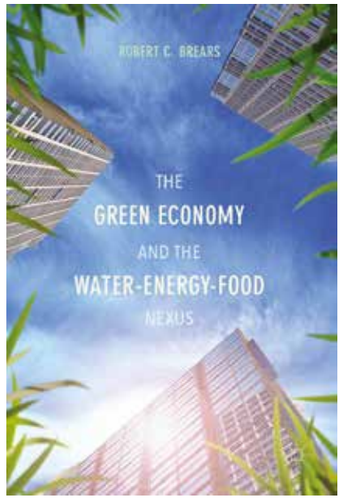

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R. **Brears**

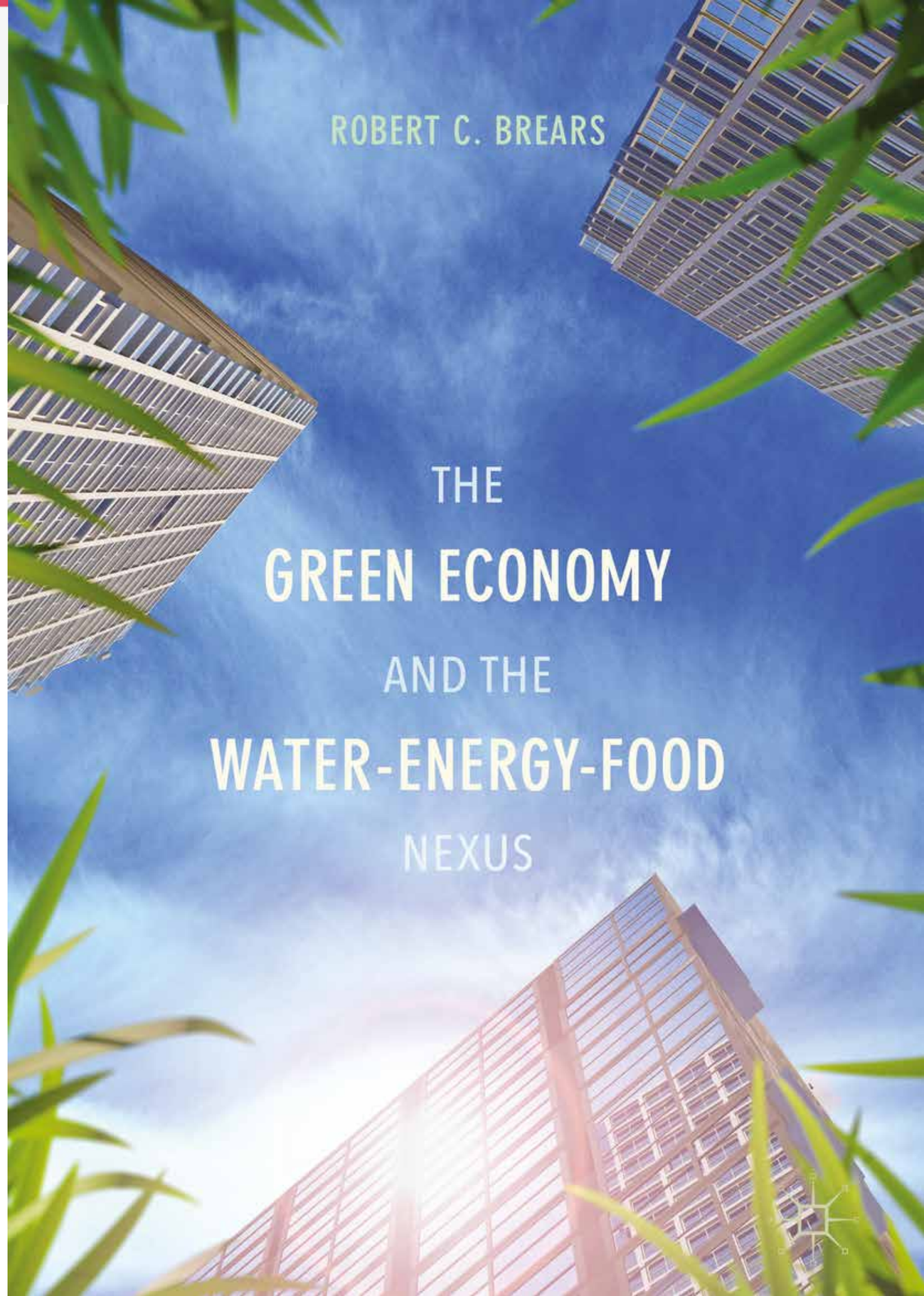
The Green Economy and the Water-Energy-Food Nexus

- **-Presents a series of case studies that illustrate how cities, states, nations and regions of differing climates, lifestyles and income-levels have implemented policies to reduce water-energy-food nexus pressures-Discusses the components of the food-water-energy nexus and the pressures it faces from rapid economic growth and climate change-Provides a review of the various fiscal and non-fiscal tools available for reducing the global demand on the water, energy and food sectors**

This book argues that a variety of policies will be required to create synergies between the water-energy-food nexus sectors while reducing trade-offs in the development of a green economy. Despite rising demand for water, energy and food globally, the governance of water-energy-food sectors has generally remained separate with limited attention placed on the interactions that exist between them.

Brears provides readers with a series of in-depth case studies of leading cities, states, nations and regions of differing climates, lifestyles and income-levels from around the world that have implemented a variety of policy innovations to reduce water-energy-food nexus pressures and achieve green growth.

The Green Economy and the Water-Energy-Food Nexus will be of interest to town and regional planners, resource conservation managers, policymakers, international companies and organisations interested in reducing water-energy-food nexus pressures, environmental NGOs, researchers, graduate and undergraduate students.



Merging Blue-Green Infrastructure with Urban Design

By Nanco Dolman

Leading Professional in Water Resilient Cities at Royal HaskoningDHV

Urban design can play a crucial role in addressing a wide range of climate-related water challenges such as water pollution, water scarcity, floods, land subsidence, stormwater management, ecosystem services and public health.

Integrated water management

Integration of water management in the different phases of design and development is essential in urban retrofit projects and new development. Approaches such as water-sensitive urban design (WSUD) provide valuable tools for strengthening the integration of water in spatial planning and urban design processes, requiring any spatial intervention or new development to be evaluated on opportunities for sustainability and innovation.

Nature-based solutions (NBS), sustainable drainage systems (SuDS) and blue-green infrastructure (BGI, e.g., urban wetlands, green roofs, swales, rain gardens, detention basins and ponds) are widely employed. These approaches enrich society by providing multiple co-benefits, including access to public green space, recreational opportunities, aesthetic enhancements, and improved management of environmental processes such as flooding, drought, urban heat, and air pollution.

Just as infrastructure and the choice of development site are critical factors in planning considerations, water management has a legitimate claim to be considered in this process. It is not just about open water and riverbanks: the choice of rainwater and wastewater systems also determine the required water storage facilities. Water is a connecting challenge in making cities resilient. Water then becomes a focal way of looking at cities and making them climate- and future-proof.

This makes it possible to move towards a balanced approach to treat precipitation close to where it lands through measures that deliver multiple benefits for water management alongside environmental and amenity benefits. New and retrofit SuDS are being developed in appropriate places and integrated with programmes to deliver better and larger sewer

BLUE-GREEN INFRASTRUCTURE

systems. More projects are taking an urban design approach by building adaptively with water in mind and investing in BGI. By strengthening BGI and giving water more space in both the public and private domain, the water city of the future has the potential to grow into a blue-green city.

Living with and making space for water

Solving the urban water assignment (required storage capacity) is centred on 'living with and making space for water'. This is both an engineering and design challenge. We must consider optional alternatives during the design process by linking the water assignment (e.g., required water storage) to BGI metrics (e.g., system and site scale measures). Figure 1 distinguishes the following four quadrants:

1. Urban typologies – land use analysis in layers
2. Water systems approach – cities as water catchments
3. The urban water assignment
4. Blue-green infrastructure – cities as ecosystem services providers

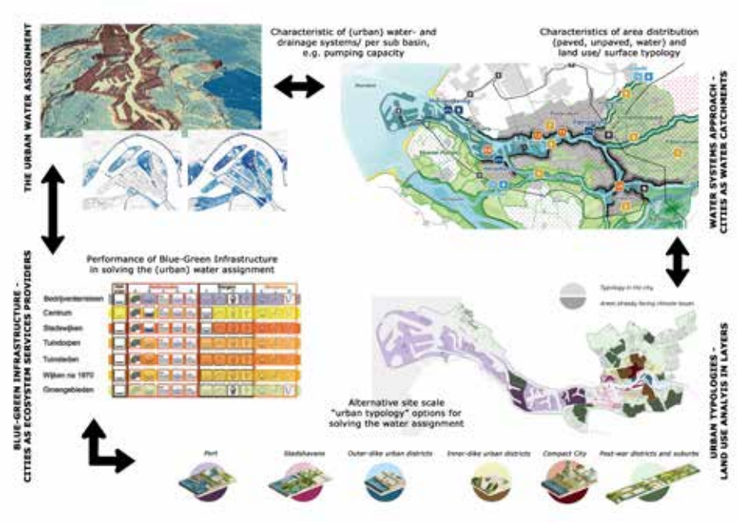


Figure 1. Linking the urban water assignment to the blue-green infrastructure metrics

Urban typologies – the Dutch layers approach

In 1998, a stratified model that distinguished spatial planning tasks based on the differing spatial dynamics of substratum, networks and occupation patterns - i.e. three layers - was introduced in the national debate on spatial planning in the Netherlands. Although using layered models was not a new thing, this model hit a nerve in spatial planning practice, initially on a national level but later also on provincial and municipal levels. Since 1998, this "layers model" has developed into an approach to spatial planning and design: the Dutch layers approach.

Water systems approach – cities as water catchments

One of the layers to spatial planning and design is the water system, both on the surface and sub-surface. Cities are part of and have developed in water catchments. Understanding both the urban and natural water system is vital when proposing and evaluating spatial interventions or new development. After the mid-19th century, towns and cities expanded to accommodate growth in industrial activity and population. Many waterways lost their infrastructure function and were filled in. During the 20th century, the urbanisation pattern became linked to the new motorway network, and water stopped contributing an organising role to urban development, whilst hydraulic engineering expertise made it possible to protect the land from flooding.

The urban water assignment

The water system analysis can be captured in a water balance or hydrological model. The starting point for the design of any urban water system is an overview of all the functions and functionalities the water system – surface water and groundwater – must fulfil, now and in a sustainable future. These functions and functionalities are the basis for the design standards that are to be applied. Such an overview of functions and functionalities – or ecosystem services – should be composed for all five types of urban water (surface water, groundwater, rainwater, wastewater and drinking water), as well as for the urban soil and subsurface.

Storage and discharge are exchangeable. Stormwater runoff that we cannot discharge into the drainage system needs to be stored temporarily in the urban environment, and we will have to discharge any runoff we do not have the capacity to store. The required storage capacity (or water assignment) does not only depend on runoff intensity but also on discharge capacity. As designers, we want to understand the relationship between the required storage capacity and discharge capacity.

Besides increasing discharge and creating more storage capacity, the runoff intensity and volume can be reduced. Runoff intensity depends on the design and construction of the buildings, streets, gardens and other urban infrastructure. Normally stormwater will drain quickly from roofs and streets to canals and ponds via the storm sewers; the delay will be no more than 5-15 minutes, and runoff losses could be 10% or less. But if we could divert the stormwater to an infiltration facility via urban groundwater - in many cases a subsurface drainage system – the delay would be hundreds or even a thousand times larger.

Blue-green infrastructure – cities providing ecosystem services

The design solutions to solve the water assignment are elaborated in city planning and in urban vision (statement) projects as well as demonstration (pilot) projects. Some practical measures and optional alternatives, both at system and site scales, include: (re) use of water, surface drainage (delay), retention (streets, parks etc.), infiltration (swales etc.), green infrastructure, storage of surface water, and adaptive and flood-proof building.

Plenty of BGI elements exist to reduce runoff and create numerous alternative options for solving the storage design problem. These alternatives must be addressed during the design process by at least considering separately a fast surface and piped run-off component and a slow runoff component through the soil/subsurface drainage system. Incorporating these best practice guidelines or BGI elements in a manual would be the next step forward.

Justification

The contents of this blog have been adapted based on part of the chapter [2] on 'Integration of water management and urban design for climate resilient cities' in the forthcoming Palgrave Macmillan book on 'Climate Resilient Urban Areas - Governance, design and development in coastal delta cities'. https://www.palgrave.com/gp/book/9783030575366

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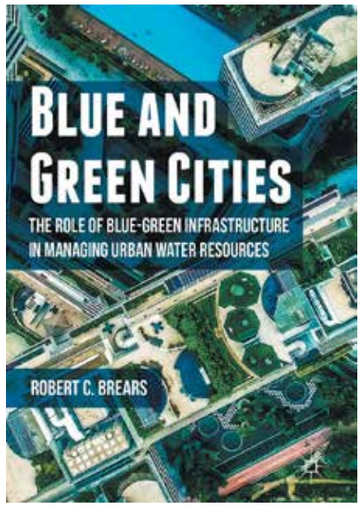

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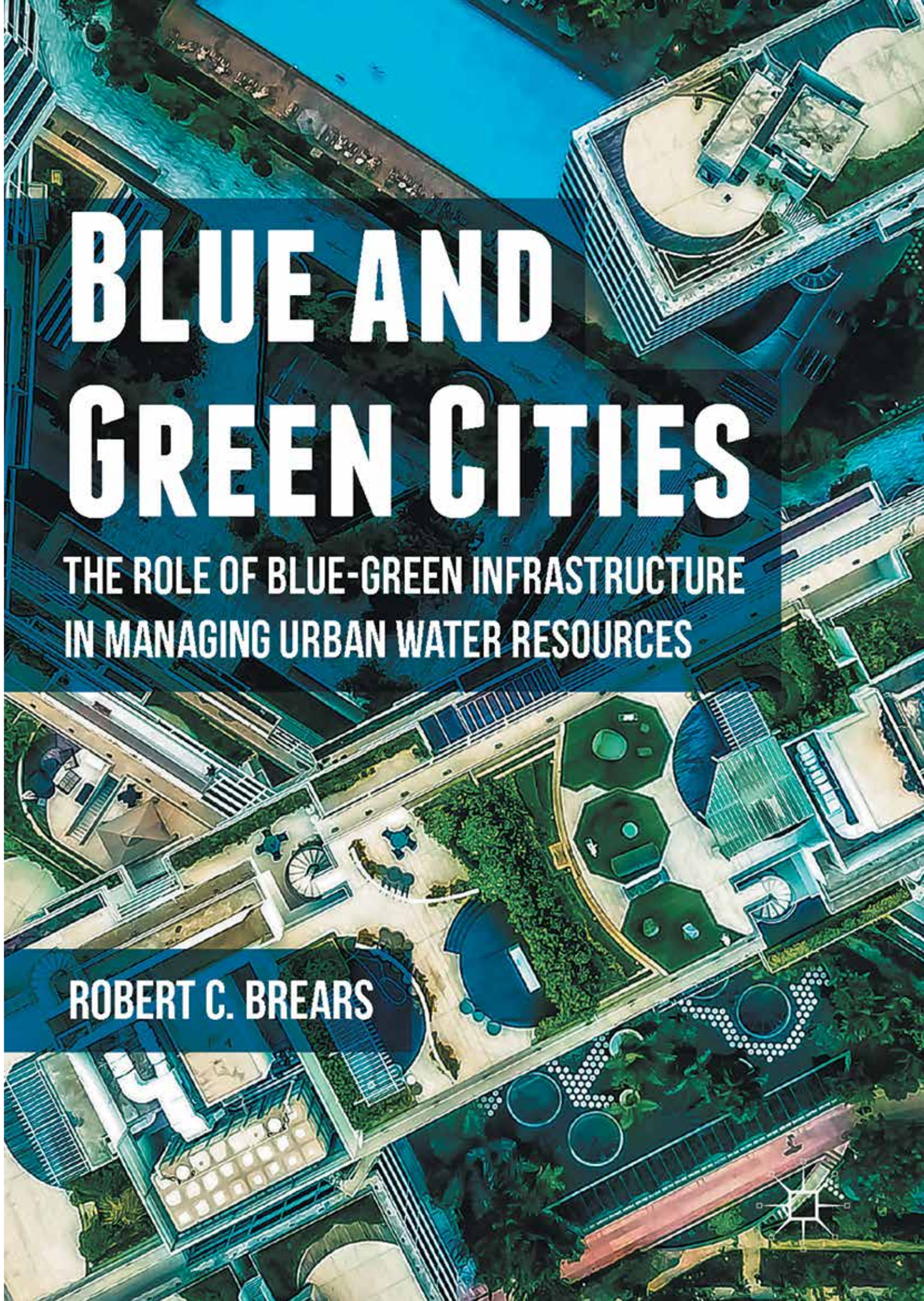
Robert C. Brears

Blue and Green Cities

The Role of Blue-Green Infrastructure in Managing Urban Water Resources

- Explores the need for alternatives to grey, “build-bigger-pipes” water management strategies
- Considers the role of blue-green infrastructure in managing water resources in an increasingly urbanised world
- Illustrates how different cities have implemented green and blue infrastructure policies

This book offers new research on urban policy innovations that promote the application of blue-green infrastructure in managing water resources sustainably. The author argues that urban water managers have traditionally relied on grey infrastructural solutions to mitigate risks with numerous economic and environmental consequences. Brears explores the role urban water managers have in implementing blue-green infrastructure to reduce ecological damage and mitigate risk. The case studies in this book illustrate how cities, of differing climates, lifestyles and income-levels, have implemented policy innovations that promote the application of blue-green infrastructure in managing water, wastewater and stormwater sustainably to reduce environmental degradation and enhance resilience to climate change. This new research on urban policy innovations that promote the application of blue-green infrastructure in managing water resources sustainably will be of interest to those working on water conservation and policy.



When Open Source Tech, Collaboration, and Best Practices Meet Open Standards: Sustainable, Smart, Resilient, Inclusive Cities

By Val De Oliveira
Press & Public Relations Manager · FIWARE

Let's picture for a second that you've been tasked with designing a brand new city or even redesigning an existing one, from the ground up, in order to tackle overpopulation, heavy air and noise pollution, inconvenient public transport, to mention but a few issues that affect 10 out of 10 metropolitan areas these days. All in all, your concept must not fall short of achieving the UN Sustainable Development Goal 11, which is about "making cities and human settlements inclusive, safe, resilient and sustainable."

In this context, your new city must be **smart** (by enhancing resource efficiency, reducing material usage, reducing greenhouse gas emissions), **resilient** (to climatic extremes), **inclusive** (socially cohesive — the sustainable development pillar of social), and **safe** and **sustainable** (in the sense of ensuring access to safe and affordable housing, reducing ecological footprints, enhancing biodiversity, generating green jobs and green growth), whilst also cost-effective to meet today's market needs.

You have been allocated a large team, and a budget is in place. Sounds straightforward, right? Well, simulating how this city may work in the real world is vital to ensure that you are covering all the bases. One may wonder, for example, when put to the test under a different climate, how might this new city concept work? If it is to be cost-effective, what piece of tech should you consider to ensure it runs efficiently? Are there any circular economy principles that could be applied to the city prototype so that it is designed for reuse and circulation of products and materials?

From budgetary constraints and a lack of technology-savvy teams to find that one solution that works across all sectors of the economy, you may soon realise that delivering your vision may require more than just an outstanding concept, a committed team and a rather generous budget.

On that note, open source software and open standards lend a helping hand to solve climate change and resource scarcity challenges. For example, open standards allow for the inte-

SMART CITIES

gration and control of various smart cities, energy, and industrial products, enhancing energy efficiency and reducing emissions whilst also streamlining private business and public administrations processes.

Without these standards, a new code would have to be written each time a component needs to talk with another. Also, open source software provides a foundation that anyone can build atop, providing a platform for SMEs, large companies and entrepreneurs to integrate their technology products with.

Food for thought, tech for good

But this may yet not be enough. Cities face different challenges across the spectrum, so the *one-size-fits-all* approach may not quite work. To achieve such a vision, solution providers, public and private stakeholders, the academic field, non-for-profit organisations and citizens must join forces and consistently co-create and share best practices to make technology and urban development more inclusive and agile.

Additionally, the digital twin concept is lending a helping hand to address a specific issue such as new urban planning, land-use optimisation, air pollution, smart manufacturing, etc. In other words, the use of Digital Twin simulations optimise towns and cities and deliver more effective city planning and citizen engagement.

If anything, the COVID-19 pandemic has shown that structures that can respond quickly to emerging challenges and opportunities will clearly have an advantage. Guided by a growing need for agility and responsiveness, more than ever before, organisations and individuals are seeking solution providers and app developers that go beyond simply using state-of-the-art tech. They are in the pursuit of providers that design solutions that can navigate complex landscapes and interact with diverse environments composed of people, places, and processes.

The continued adoption of analytics in city governments is certainly not slowing down and speaks volumes about the innovative tools and solutions available to cities. As more sophisticated technologies such as machine learning, AI, and digital twins are deployed, discussing how such practices are effectively reshaping urban policy must be on everybody's mind.

It is undoubtedly a constant topic for the FIWARE Community members, and they certainly bring a thing or two to the table. In the spirit of collaboration that this community fully embraces, this article has been put together by **Andrea Cruciani** (WiseTown), **Andrea Gómez** and **Antonio Jara** (HOPU), and **Val De Oliveira** (FIWARE Foundation). They will walk you through city-level projects to convey the potential of data- and tech-enabled innovations for city governance. Ever wondered what smart ports and public governance have in common? Read on.

Green and Smart Ports: New Collaboration Opportunities for Cities and Ports

The relationship between cities and ports is becoming more direct, and ports are investing to be part of climate change mitigation.

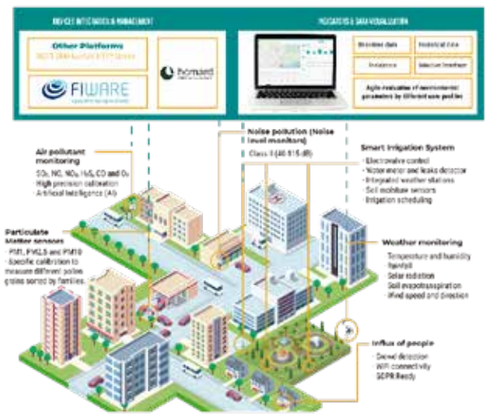
By **Andrea Gómez**, PhD, CMO, and **Antonio Jara**, CEO, HOPU

As an economic driver of cities, ports are one of Europe's most valuable assets – with 2 million direct and indirect employees in 2018 – but their impact on the environment is an important field to be analysed and controlled. An example of this duality is cruise ships, which generate economic wealth for a given city but pollute five times more than road traffic.

"*Smart ports should monitor sulphur oxide and nitrogen oxide – brought about by burning fossil fuels – and particulate matter [PM], which is harmful to respiratory systems, and noise that affects the quality of life of claiming areas. In addition, luminosity also has a significant effect on biodiversity and citizens' health*," said Antonio Jara, CEO, HOPU.

HOPU, a company focused on the research and development of IoT and smart cities solutions – and a FIWARE Foundation member* – has come up with an innovative environmental monitoring dashboard based on AI predictive models for ports, using high-quality enriched data. Its objective is to collect, analyse and visualise large amounts of data to provide a unique indicator that facilitates the understanding of the port's state, its impact on the city and the main pollution sources.

On that note, HOPU manufactures IoT-based environmental monitoring devices called Smart Spots. These measure gases such as sulphur oxide and nitrogen oxide in specific areas and in real-time, detect toxic substances such as alcohol and volatile organic compounds (VOCs) and detect PM to identify specific nanoparticles such as dust (PM10), pollens (PM10-PM40), pollutants (PM2.5) and viruses (<PM1). This solution uses technologies based on European standards such as the CEF Context Broker and FIWARE, promoting the effective use of open source technological resources.



Smart Spot device in current use on ports. Image provided courtesy of HOPU.

A sea of opportunities

The relevance of HOPU in ports is growing. Nowadays, the company has devices in three ports that are working to establish indicators to evaluate their environmental impact. For the Pixel project, in collaboration with Prodevelop and the Polytechnical University of Valencia, HOPU has deployed Smart Spots in Thessaloniki, Monfalcone and Bordeaux ports.

Recently, the company was crowned the winner of the FIWARE Zone Challenge for the Algeciras Port, where more than 25 devices will be deployed in 2021. Supported by the Junta de Andalucia and Autoridad Portuaria de la Bahía de Algeciras (APBA), the largest port of Spain in Algeciras, Cadiz, the project uses 25 devices to monitor and improve the port sustainability in the territory. They will collect real-time contextual data to be processed and modelled by an AI to understand the impact of the different actions carried out in the bay port of Algeciras in Spain.

From the origins of the pollution, gas zonification, odours (VOCs), PM (dust) monitoring and the validation of the different sustainable actions. With the help of AI, based on Recurrent Neural Networks (RNNs), this project aims to reduce its environmental impact, improving the air quality of this territory.

SMART CITIES

The Latest Trends of Urban Insights and Forecasts
By **Andrea Cruciani**, CEO at TeamDev and founder at WiseTown

Public administrations face daily challenges. From having to deal with tight budgets - whilst also keeping the quality of services - to addressing the enormous technological, economic, environmental and social shifts of today's society - that do not always meet the desired management optimisation standards, pressure is piling up. In that sense, it is essential that public administrations representatives are able to plan, implement and monitor effective governance measures.

This is why there is an increasing demand for dialogues on the centrality of data in the city. Be it to remediate heavy air and noise pollution, optimise mobility options, save its inhabitants' time and money (the list goes on), cities worldwide are taking advantage of analytics to foster improved municipal policy and performance. For instance, cities use data to 1. represent their current status, 2. manage ongoing situations, 3. predict the evolution of a specific phenomenon, 4. simulate city developments as one or more parameters change.

Tech at the forefront of cities development
More than ever before, cutting-edge technologies are becoming fundamental for cities' management processes. The full picture can only be understood by overlaying the information from multiple sources such as sensors, human research, weather data, satellite data, etc.

Managing real-time scenarios is the very first step following the occurrence of a given phenomenon. It requires the involvement of various stakeholders interested in both the organisational and operational parts. As the data sets get richer, it is possible to identify patterns or use statistical models based on historical series that allow us to predict specific phenomena and act promptly to mitigate those that can be harmful.

Next up is the possibility of evaluating how one or more phenomena can impact the concrete aspects of city life by simulating different scenarios. These processes are typically addressed by the WiseTown® Geoanalytics ecosystem, which analyses satellite data, open data and sensor data. By adding data related to interaction with citizens, civil servants, and other stakeholders, it is possible to create a city's digital twin.

Envato elements, reworked by the WiseTown team.

In simpler terms, it is a virtual replica used to simulate and test the waters before a new product or service is launched onto the market. The approach bridges the gap between the physical and digital world, allowing companies to enhance their business portfolio, better manage their resources and deliver compelling customer experiences by gaining a deeper understanding of how their solution(s) may affect their surroundings.

An example is the urban green analysis that can be monitored in the vegetative state (NDVI from satellite), well organised for maintenance (operations and workflow tasks), estimated for the problems that may arise (forecast for diseases and other events) and simulated in different scenarios (urban green planning). This approach is also applied to mobility, health, urban planning, security and all the city aspects.

For more details on urban data and how the WiseTown® Geoanalytics ecosystem can help your city to explore all the available opportunities that new technologies offer for cities and communities, visit the website.

*Headquartered in Berlin, Germany, FIWARE Foundation is a non-profit organisation that drives the definition and encourages the adoption of open standards — **implemented using Open Source technologies and reference architectures** — to ease the development of smart digital solutions across multiple domains, based on FIWARE technology. Founded in 2016 and with 415+ global members and partners, the foundation has Atos, Engineering, Red Hat, NEC, Telefónica and Trigyn Technologies among its Platinum members. FIWARE has been a strategic partner of Robert Brears since 2018.

PALGRAVE STUDIES IN CLIMATE RESILIENT SOCIETIES
Series Editor: **Robert C. Brears**

This book presents new research on policy innovations that promote the development of the circular water economy. In contrast to the linear economy, the circular water economy promotes the reduction of water consumption, reuse of water, and recovery of resources from wastewater to not only increase resilience to climate change but also to reduce greenhouse gas emissions resulting from the provision of water and wastewater-related services. Providing a series of in-depth case studies of important locations in differing climates around the globe that have implemented a variety of policy innovations to develop the circular water economy, this book is a valuable resource for water and resource conservation managers, policymakers, international companies and organisations interested in the circular economy, environmental NGOs, researchers, as well as graduate and undergraduate students.

- Systematically reviews policy innovations to develop the circular water economy
- Illustrates how leading locations from around the world have developed the circular water economy to increase resilience to climate change while reducing emissions
- Provides 'best practices' for other locations around the world aiming to implement the circular water economy

Robert C. Brears is the author of *Urban Water Security, The Green Economy and the Water-Energy-Food Nexus, Blue and Green Cities, Natural Resource Management and the Circular Economy,* and *Climate Resilient Water Resources Management*. Robert is the founder of Our Future Water, Mark and Focus, and Mitidaption.

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SERIES EDITOR: ROBERT C. BREARS

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The Smart City as an Environmental Steward

By Jim Craig, Product Manager, Red Hat Global Government &
Leslie Hawthorn, Manager, Red Hat Open Source Program Office

Smart cities should be so much more than efficient traffic and trash management.

Okay, first things first, there is no such thing as trash in smart cities, right? We're building a new way of doing things and implementing a smart city along linear economy lines isn't as smart as it could be. Below is what we mean by circular economy.

Our first step is to zoom out and look at the city in all its fully integrated "system" of inputs and outputs. This new holistic perspective allows you to identify relationships between subsystems, which then map out the new building blocks of a sustainable smart future.

This connected subsystem approach is at the centre of the FIWARE architecture, allowing civic planners to imagine big and then get there incrementally. Let's go for a ride around a sustainable smart city and check it out.

Using my smart city app, I hire a bicycle from a shared service. The app gives us some recommended routes, based on my intentions for the day, highlights special offers and attractions, and notifies us of the air quality, temperature, and weather forecast for the rest of the day.

As we cycle through the streets, private cars are absent. Instead, we find many cyclists and pedestrians, alongside electric trams and buses powered by locally generated renewable energy. Public transit is centrally managed, load-balanced and delivered by the smart city's management platform. The air feels clean, and the roads feel safe.

Older buildings have been reclaimed, rather than demolished, and all buildings are interconnected to share utility services, such as energy, forming part of a wider smart city nervous system. Vertical and rooftop farms grow food for local consumption, with soil moisture, water levels, temperature and other key variables monitored and controlled by the agri-food subsystem, ensuring maximum yield and quality for minimal resource consumption. The green walls also help to reduce urban heat islands.

Everything is reused, recycled, or composted, from electronic devices and clothes to heat and water from buildings.

To read inspiring stories on how open source software, open standards, and data, combined with open source principles of sharing and reuse, help design sustainable smart cities now, mouse here.

*Red Hat is a Platinum Member of FIWARE Foundation, a strategic partner of Mark and Focus Magazine.

Future Cities: Smart, Resilient, Inclusive and Sustainable

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Reclaiming the Public Space for People and Nature

By Sofia Aivalioti
Innovation Consultant, Bax & Company

Cities are fascinating. They are the places where most of us live, work and grow. If cities are not designed for their people, then we are doing something wrong. What makes a city thrive? What makes a city a good place to live? Cities should first cover our necessities, such as access to clean water, shelter, and safety, and offer opportunities for work and socialising. Public spaces play an important role in some of these aspects, and they can help give people fulfilling lives. However, at the moment, we do not make the most of public space.

For the past 100 years, ideas on how best to design cities have generated several conflicts. Many citizens decided to make these decisions themselves, reclaiming their public space and the streets. In a post-pandemic world, a citizen-centric planning approach for cities has gained popularity for a better recovery achieving “build back better”. Why is reclaiming the public space for people and nature a great idea?

City Scales: From on Foot to by Car

Cities did not always have the same structure as we see today. In the past, cities used to have high density, low rising buildings mixing various uses. The distances between work and home were far less, and the personal perception of distances was different. The available modes of transport and the speed of those transports defined the distances that people used to move daily. In the 60s and 70s, we moved from that human-scale city model to a car-centric city. This changed everything. The cluttered blocks of buildings for residential use were considered remnants of the past that needed to be replaced. The vision back then that shaped today’s cities was constructed by wide boulevards that facilitated a large volume of cars to cross the city from one side to the other as fast and direct as possible. Streets became impossible and dangerous to cross by pedestrians, having six or eight lanes of motorways. A characteristic example of that era that has been heavily debated is the New York of Robert Moses. He prioritised motorway highways across the city to connect the suburbs and favour cars over public transport. Prioritisation of cars offered

RECLAIMING PUBLIC SPACE

us the freedom to move but also doomed the overall health of the population in and around the cities. Air pollution, exposure to high noise levels, and promotion of a sedentary lifestyle made cities dangerous places to live, let alone thrive. The space taken for parking, roads and highways stole the community life. Entire neighbourhoods became soulless, areas where people do not want to socialise, cross the street, or shop. Places unsuitable for children to play.

Opposition to Car-Centric Construction

The opposition to car-centric developments has been strong and persistent. Citizens defended their neighbourhoods, streets, nearby parks, and even big trees that represented the essence of a community. Various protest movement sprung to prevent the construction of streets or buildings that would steal public spaces and the life of the neighbourhood. In the 1970s, the London-based political movement "Homes Before Roads" emerged to oppose plans to construct a system of four interlinked concentric motorways through and around London. In 1974, in Bogota, the capital of Colombia, city officials authorised Jaime Ortiz Mariño and more than 5,000 bike-enthusiasts to close traffic for three hours on 12 kilometres of avenues and ride freely on their bicycles through the centre of the city. In that moment, the Ciclovía movement was born. It started first as a protest and transformed into a weekly holiday where citizens enjoy family walks and bike rides, recovering the urban public space ever since. In 1991 another organised movement, "Reclaiming the streets", took form in London, occupying highways for street parties. They reclaimed the streets for the people. This action was copied in cities around the world. In 1992 the critical mass movement started in San Francisco, where cyclists moved as a unique vehicle blocking the traffic to declare their presence in the city's life and demand more bike-friendly public space. The event is still happening regularly in many cities all around the world and has been ever-growing. Critical mass events have made a difference in many cities, changing public administration views on the bike's role, and making bikes an essential element in urban mobility. Such movements continue to this day and promote city living alternatives, allowing people to enjoy their environment away from noise and pollution.

Another influential element of this historical shift that shaped our cities was the 1973 global oil crisis. This halted the car movement and, making cars an impossible mobility option. At that moment, governments had to act. Many governments in Northern Europe decided to invest in long-term policies to move away from the dependence on cars. The Netherlands and Copenhagen are two prominent examples of this. Across the Netherlands and Denmark, cities built bike infrastructure, people-friendly streets that maintain each city's character, and invested in high-quality public transport. Five decades later, Amsterdam and Copenhagen are leading authorities on bike-friendly planning. They are leaders of this movement, and people worldwide visit them to understand how this model works and take ideas back home. At the same time, they kept their original building stock, with low rising buildings and smaller streets suitable for walking and shopping.

Liveable, Walkable Cities Today

In recent years redesigning cities for health and liveability has become a greater priority – at least in Europe. The superblocks of Barcelona present an important urban intervention held up as an example for imitation. In 2016 the Catalan city decided to stop the flow of cars within nine building blocks located in the neighbourhood of Poblenou, eliminating the car flow and creating spaces with playgrounds, benches, picnic tables, trees, and flowers. Initially, the project gathered strong opposition from car owners and shop owners, but today in most cases, the complaints have been replaced by praise, and locals feel fortunate to live within a superblock. Superblocks transform the neighbourhoods where they are implemented, giving public space to the people, and creating more lively and vibrant neighbourhoods. This can come at the cost of raising the prices of properties, but in the case of Poblenou, many houses around those blocks are social housing, ensuring some stability in the housing market. Currently, Barcelona has implemented a new superblock in the Sant Antoni area - a very central and busy part of the centre. The city is also preparing a huge transformation plan of twenty-one streets and twenty-one road junctions, converting them into parks and public squares in the coming years. Barcelona suffers from poor air quality, classified as one of the most polluted urban areas in Western Europe and failing to comply with European air quality regulations. As one of the densest cities in Europe, Barcelona also lacks green spaces. Reclaiming the public space and making it safe and greener for people is not a luxury but a necessity in this city. The opposition will always be strong to such plans, but over time, citizens will reap such projects' benefits in terms of both mental and physical health.

Slow Cities, Slow Streets

Some cities have adopted policies and practices to transform to create slower streets. The slow city concept promotes an entirely alternative way of living focusing on young people, employment, environmental protection, and rural development. The movement of slow cities "Cittaslow", born in Tuscany in 1999, provided an alternative approach to urban development. Municipalities joining this movement place citizens and nature in the centre of their design. They also focus on local food consumption, eco-gastronomy, and promotion of local art, culture, and history. Small municipalities with less than 50,000 inhabitants must comply with a list of criteria, including topics on environmental policies, urban design, support of the local economy, conviviality, and hospitality to be part of the network. Slow Cities movement now has 277 members around the world. Slow streets support community-based development, prioritising quality of life and giving space to pedestrians and cyclists. The slow streets programme blocks streets to traffic, decreasing the lanes where cars can pass through and the speed limit. In various UK cities and towns, school street closure schemes have been successfully trialled, where cars are prevented from passing by the school gates at drop off and pick up times.

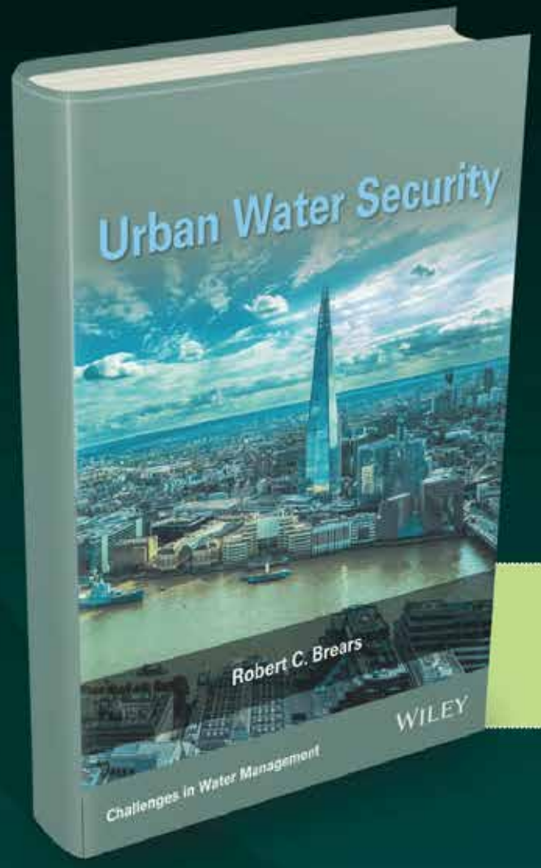
Planning in a Pandemic

The years of COVID-19 are very relevant to the movement of transforming cities for liveability. Since the pandemic started, cities worldwide doubled or tripled their bike infrastructure, as it was an option for safe commuting maintaining social distancing. For the same reason, areas around schools also expanded, reducing crowdedness, and making it safer for parents and children. On other occasions, closed streets were occupied by extra tables from nearby cafes and restaurants, allowing for safer dining during the pandemic. In big cities such as Madrid and Paris people experienced cleaner skylines and fresher air, for the first time realising how noisy and polluted their homes are due to the constant flow of cars. After the first months of lockdown, cities everywhere started to plan for more car-free areas as permanent solutions, transforming important areas into gardens, combined with bike lanes and spaces for social activities.

In the meantime, in the absence of nightlife, restaurants and gyms, European citizens re-learned to appreciate walks in the park and doing more exercise outdoors. Most people visited their city parks for the first time and discovered new walks and routes in nearby natural areas. Others realised the absence of quality parks in their proximity and wished for more and better green public spaces close-by their homes. In many countries, citizens had or have limitations of movement to only a couple of kilometres from their home. With this restriction in place, people revaluate their neighbourhoods and services in proximity. To solve this, along with many other urban problems, long before COVID-19, a new ambitious urbanistic concept was born. The 15-minute city by Carlos Moreno. This framework designs the cities we would like to live in, not the cities we have. The 15-minute city promotes walkable and bikeable neighbourhoods where the car is not needed, enabling citizens to move in an active way. Access, proximity, and safety are key concepts, and the reduced need for travel could also reduce the cost of transport infrastructure. But it is not all that simple.

Where to Go from Here

Concepts such as the 15-minute city must be well embedded in all agendas. Citizens and stakeholders' consultations and co-creation should be considered, and well-planned alternatives to current practices and uses must be painstakingly investigated. Cities are networks with flows of people and services. How can we best serve those flows by bringing out the maximum positive outcomes to our lives? Could clean air and less noise pollution be a reality even after the pandemic? How can we quickly transform our cities to become suitable places to live and thrive, with low traffic, places that promote physical and mental health and support the environment. On the one side, city administrations must ensure that those plans are a priority and secure the necessary funding. On the other side, the citizens should be part of creating those plans and shaping the neighbourhoods they want to live in.



Urban Water Security

Edited by **Robert C. Brears**

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In the 21st century the world will see an unprecedented migration of people moving from rural to urban areas. With global demand for water projected to outstrip supply in the coming decades, cities will likely face water insecurity as a result of climate change and the various impacts of urbanisation. Traditionally, urban water managers have relied on large-scale, supply-side infrastructural projects to meet increased demands for water; however, these projects are environmentally, economically and politically costly. *Urban Water Security* argues that cities need to transition from supply-side to demand-side management to achieve urban water security. *Urban Water Security* provides readers with a series of in-depth case studies of leading developed cities, of differing climates, incomes and lifestyles from around the world, that have used demand management tools to modify the attitudes and behaviour of water users in an attempt to achieve urban water security.

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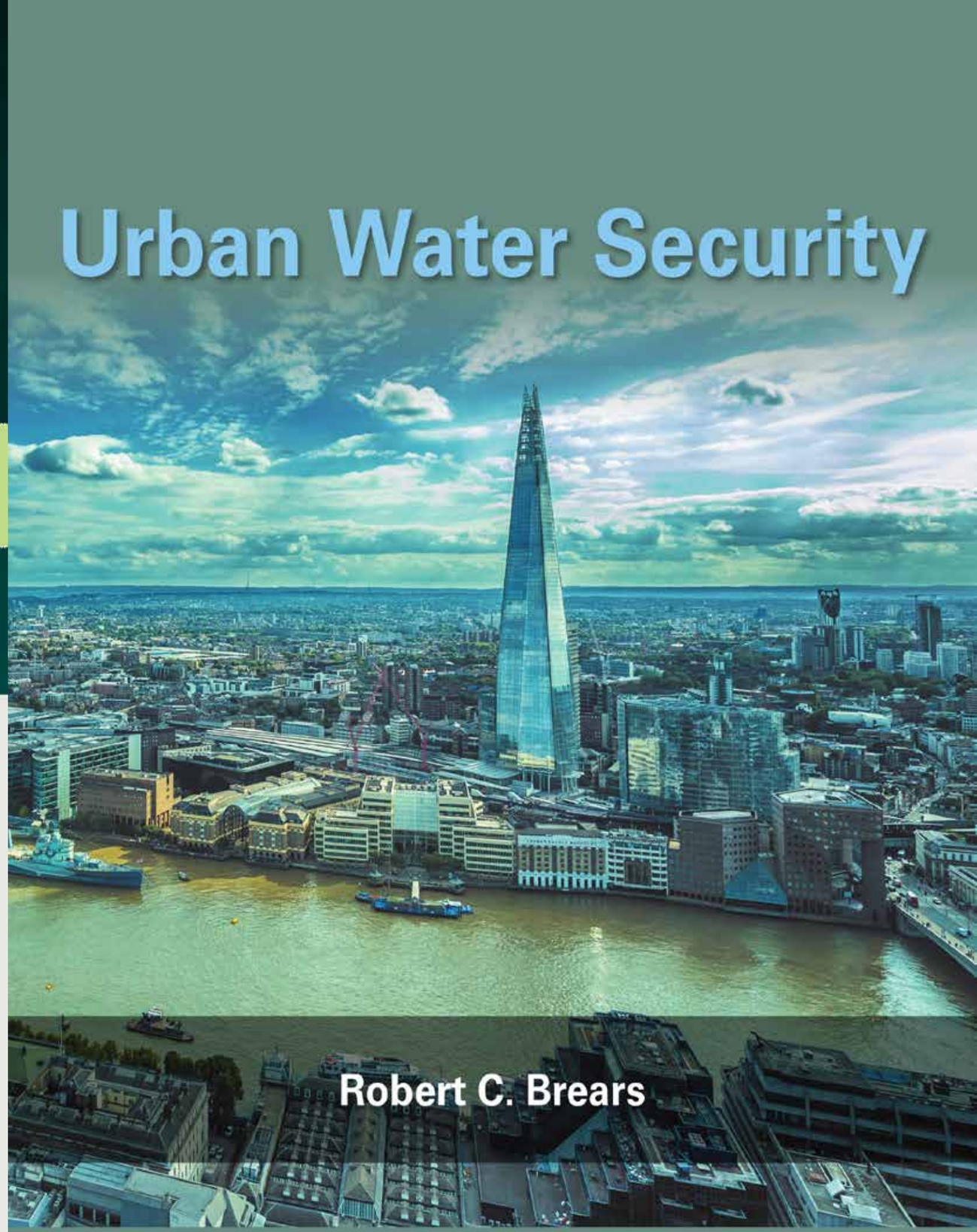


A Reflection Upon Water: Lessons Learned from Water Provision in Developing Countries

By Lucy White

Introduction

This article explores four different approaches in providing water services to citizens in developing countries: privatisation, public entities, universal free daily water allowance, and community-led initiatives. These approaches will be examined in the context of Manila in the Philippines, Cochabamba in Bolivia, Durban in South Africa, and Nakasongola in Uganda.

Is water a public good or a private good? The obvious answer might first appear to be that water is a public good because it is a basic human right and a resource from the natural commons. While this holds true, the question requires deeper analysis. Large-scale infrastructure projects and water treatment units are imperative to connect water from its natural source to the taps in our homes, which requires significant investment and technical expertise. When we factor this into the equation, is water still a public good?

One argument might be that water is a public good, and therefore it is the government's responsibility to provide clean, safe and potable water to its citizens. But when we look at developing countries, we often find that governments have failed to expand water access to all segments of the population, which is partially explained by the huge financial burden governments face when dealing with water provision. By assigning the responsibility of water provision solely to the government, we see a number of negative unintended consequences unfold, such as emerging informal black markets where water is sold to unconnected citizens (typically the 'urban poor') for up to 10 times the price that citizens connected to regulated water services pay. In order to overcome this problem and alleviate the burden faced by governments, it was recommended that the private sector should take over this responsibility. Given that water provision requires significant investment, along with the private sector's inherent motives of profitability, accessing untapped consumers and gaining new market power, it seemed logical that the private sector would be successful in expanding water services. This led to the onset of a wave of water privatisation in the 1990s

PROVISION OF WATER

under the Washington Consensus. In a nutshell, the Washington Consensus advocated neoliberal policies of a 'free market' along with the reduction of state involvement.

We will now explore the case of water privatisation in Manila, in which one private company succeeded and another failed, to show that, ceteris paribus, endogenous factors within private companies partially determine the outcomes of water privatisation. We will then evaluate a case of failed water privatisation in Cochabamba in Bolivia to show how underlying social and political factors can influence the outcomes of water provision. In this case, Cochabamba's water provision was better suited under the control of public sector entities. Following this, we will explore the feasibility of a free daily water allowance in Durban in South Africa to show how universal policies can inadvertently reinforce pre-existing social inequalities. Finally, a case study of community-led water provision in Nakasongola, Uganda, will be explored as an alternative solution to government and private sector initiatives.

Case study: Successful Privatisation in Manila, the Philippines

In the 1990s, Manila's water supply was operated by a public sector entity called Manila Waterworks and Sewage System (MWSS). However, MWSS struggled to provide its population with adequate water supply; it supplied 16 hours of water a day to just two-thirds of the population. This, in part, triggered the National Water Crisis Act of 1995, which allowed water provision to be privatised. The International Finance Corporation (IFC) of the World Bank and the Asian Development Bank were closely involved in Manila's water privatisation, which was one of the world's largest water privatisation deals. Manila was divided into the East zone, and the West zone and two separate concessionaire contracts were granted to each of the zones: Manila Water Company (a subsidiary of Ayala Corporation) won the bid for the East zone, and Maynilad Water Services (under Suez and Benpres Holding) won the bid for the West zone. Both of the companies agreed to service MWSS's debt. Of these two private sector companies, Maynilad Water Services went bankrupt in 2005 and handed control back to the public entity MWSS, whilst Manila Water Company still operates today. It will now be explored how the success of water privatisation cannot be assumed but rather depends on each individual company's endogenous factors and strategies to cope with exogenous shocks.

Shortly after the concessionaire contracts were granted in 1997, the private companies were both faced with two serious exogenous shocks that may have affected their ability to expand supply coverage and improve services. The first exogenous shock was a severe drought caused by the strong El Niño events of 1997/98, which greatly affected the Angat Reservoir, from which 98% of Manila's water supply is drawn. The second exogenous shock was the Asian Financial Crisis of 1997, in which the Asian market experienced a series of currency devaluations. Currency devaluation almost doubled MWSS's dollar-denominated debt, which was now the responsibility of the two private companies. The extent to which these exogenous shocks explain the bankruptcy of Maynilad Water Services is somewhat limited because, under the same exogenous shocks, Manila Water Company remained resilient. Thus, we will now turn to endogenous factors to build our understanding as to why one company succeeded while the other did not.

Firstly, in response to the Asian Financial Crisis, Manila Water Company adopted better financial management practices than Maynilad Water Services. Manila Water Company's strategy was to gain small-sized loans from local banks, slow down its capital expenditure and target areas that were likely to produce financial improvements with limited capital. Maynilad Water Services, on the other hand, sought multi-million-dollar loans and did not target areas of water loss. This led to the company accumulating more financial losses and, eventually, forced it to default on its loan payment.

Secondly, different approaches to corporate governance explain why Manila Water Company's operating costs were much lower than those of Maynilad Water Services. Manila Water Company kept a distance from Ayala Corporation and outsourced its work while Maynilad Water Services, on the contrary, gave contracts to its holding company (Suez and Benpres). By shielding its contracts from competitive bidding, Maynilad Water Services incurred extortionate costs.

Thirdly, one challenge was to transform the public utility (MWSS) into a customer-driven private company. Manila Water Company introduced decentralised decision-making and incentive mechanisms to encourage good performance and retrain former MWSS employees. Maynilad Water Services, on the other hand, brought in a large number of its staff from Suez and Benpres and gave them managerial positions, despite them having no experience in the water sector, as opposed to retraining former MWSS staff. This ultimately lowered the morale and work ethics of national staff at Maynilad Water Services.

Fourthly, operational management played a role. Within less than a decade, Manila Water Company reduced its non-revenue water from 58% to 35% of former levels under MWSS. This was because it established a 'Water for the Community' programme, which extended water supply services to areas with numerous clusters of lower-income families. Under the programme, several families could share one connection, which allowed them to split the cost of consumption. Moreover, Manila Water Company imposed a zero non-revenue water rule to minimise illegal connections, leakages and water contamination. Operational management in Maynilad Water Services, however, had the opposite outcome. Non-revenue water actually increased, from 64% to 69%. Though Maynilad Water Services created a similar 'Water for the Community' programme, families accessed individual water connection points as opposed to shared ones, meaning that the cost of consumption was not spilt. In addition, the individual water connection points left lines exposed to illegal connection, which partially explained Maynilad Water Services' increased non-revenue water.

Lessons learnt

Under Manila Water Company and Maynilad Water Services, water connections in Manila increased by 30% in just five years, which, based on historical performance, would have taken the MWSS 30 years. Even though Maynilad Water Services went bankrupt and handed control back to MWSS in 2005, the MWSS was re-privatised in 2007 by DMCI-MPIC Water Company, which suggests that water provision in Manila is better suited under privatisation. Indeed, both Manila Water Company and DMCI-MPIC Water Company continue to be in operation today and are living proof that water privatisation can be a success. An important lesson to learn from Manila is that if we reject water privatisation outright on the basis of inherent incompatibility between the private sector and water provision, we may deprive the public of a valuable service. Indeed, the success or failure of water privatisation cannot be generalised. Rather, the success of water privatisation depends on the endogenous factors of each individual company rather than the private sector as a whole.

Case Study: Failed Privation in Cochabamba, Bolivia

Due to water scarcity and dependency on water for irrigation in Cochabamba, water has long been one of the most important underlying political issues for citizens of the city. The rationale for privatisation was that Cochabamba's water, which was supplied by the public enterprise 'SEMAPA', failed to connect almost half of Cochabamba's population to the public water system. Given the historical context of Latin America's debt crisis in the 1980s and the onset of the Washington Consensus, it is no surprise that Bolivia's water provision, like that of Manila's (above), was privatised. In 1999, Bolivia's government passed 'Law 2029', which granted monopoly rights over water sources to private companies. Thus, SEMAPA was privatised, and urban water monopoly rights were given to the private company 'Agua del Tunari', led by Bechtel Corporation. Similar to the case in Manila, Agua del Tunari had to inherit SEMAPA's debts.

Water privatisation in Cochabamba was extremely short-lived. Within months, by January 2000, water rates had increased by approximately 100%, and, for some families, bills increased by 200% despite having access to water for only two to three hours a day. Hence, water prices increased while the quality of water services had not. The price increase can be explained by Agua del Tunari's exclusive property rights over water, which meant a) Agua del Tunari could impose additional costs for future services that had not yet been developed, and b) residents could be charged for collecting water from their own hand-made wells for the very first time, imposing a new cost. Historically, many residents in Cochabamba had built wells as an adaptation mechanism to overcome SEMAPA's failure to supply water. Through the lens of Foucault, community-built wells are 'lacunae' and 'floating mists' to navigate through a failed state system. While these wells served as an effective alternative to SEMAPA's failed water provision, they could not withstand the power of Agua del Tunari's exclusive property rights.

The citizens of Cochabamba rejected the idea that a company could make profitable investment over a basic human right at the detriment of natural resources, which draws upon theories of the Tragedy of the Commons and neoliberal ideology. In reaction

PROVISION OF WATER

to the combination of price hikes and the appropriation of a natural environmental good, the citizens of Cochabamba embarked on a mass protest in what became known as 'The Water War'. In January 2000, 100,000 protestors took to the streets. Eventually, in April 2000, the government was forced to break its contract with Agua del Tunari and transferred water utility back to the municipal government under SEMAPA. The government passed 'Law 2066', a water law that recognised citizens' rights. Still today, in 2021, SEMAPA continues to supply water in Cochabamba and water coverage has been extended.

The underlying importance of The Water War was a struggle for a new form of democracy from the people. The Cochabamba Water War has been widely accredited for starting the wave of protests that led Bolivia to elect its first indigenous president, Evo Morales, in 2005. The Water War of 2000 came after fifteen years of ineffective resistance against neoliberal structural adjustment policies.

Lessons learnt

There are a number of lessons to be learned from Bolivia. Firstly, water is a highly politically and contentious good. Secondly, there is a hierarchy of stakeholders and interests involved in the water arena, from powerful multinational companies and international financial institutions to governments of low-income countries, to citizens who lack participatory parity. When citizens come together to form well-organised protests, they have the ability to challenge those at the top of the power pyramid. Thirdly, it can be argued that granting exclusive monopoly rights over water to one single company is dangerous if the company does not account for local contexts, needs and sensitivities. Perhaps water privatisation in Bolivia would have had a higher chance of succeeding had it been part of a hybrid system in partnership with the public sector SEMAPA, or had it not been granted exclusive property rights over all sources of water, particularly over water from community-built wells.

Case study: Universal Free Water Policy in Durban, South Africa

In the 1990s, 250,000 households in Durban's townships had no access to clean water or sanitation. This demonstrates the role of water in the reproduction of socio-spatial inequalities and power relations, which draws upon theories of the political ecology. Political ecologists argue that the world water crisis is socially produced, that we must recognise the power relations through which resources are both produced and distributed. Under this thinking, political ecologists reject Malthusian theories of water scarcity, as they argue that water scarcity is a social creation that can be amended through equitable redistribution.

A shift in political power and ideology occurred at the onset of Nelson Mandela's presidency in 1994. This, along with a growing need to prevent disease outbreaks such as cholera, triggered Durban's municipality (through eThekwini Water Services) to provide a daily allowance of 200 litres of free water to all households in 1998, which increased to 300 litres in 2008. This transition represented the start of a free basic water policy. The Durban model was scaled-up to the national level and led to the creation of the 1998 National Water Act, which committed to the basic right of all to have access to a safe and sufficient supply of water. While this policy was, and continues to be, very effective in committing to the water needs of low-income residents in informal settings, there was significant pressure to recover the running costs incurred from free water distribution. The proposed solution to this was to disconnect households that had not paid their water bills on time. This disproportionately affected low-income households because these households were more likely to be connected to the water system through inefficient, leaky and poor-quality plumbing, which inevitably meant that a proportion of their free daily water allowance was wasted. As a consequence, less of their water consumption was free, and more of it was billed.

Lessons learnt

The birth of a free basic water policy can go a long way in meeting the water needs of the urban poor. However, if infrastructural issues such as leaky plumbing are concentrated in townships and remain unaddressed, then socio-spatial inequalities will continue to be reproduced despite pro-poor water policies. Thus, there is a disjuncture between water policy and water in practice. It is recommended that all water provision policies and projects should be followed through from the design, implementation and evaluation stages thoroughly in order to assess the impacts and outcomes effectively.

Case Study: Community-led Initiatives in Nakasongola, Uganda

In Uganda, the government has failed to provide reliable, clean, safe and potable access to water to all of its citizens. The absence of water provision is stark in remote villages, such as in Nakasongola district. The nearest water source to these village communities can be up to 5km-10km away. Further exacerbating this issue are additional barriers of lack of transport and poor infrastructure, which forces citizens to walk arduous long distances to collect water. As a solution to immediately meet the water needs of these communities in Uganda, in 2020, a non-profit foundation named Uroda Venture created a self-sustaining, low-cost solution. Avoiding the bureaucratic upheaval of international financial institutions, Uroda Venture raised the necessary total funds of €15,000 from private donations and crowdfunding for its self-sustaining water project. Uroda Venture drilled 90 meters down to the nearest water source and now pumps water, using a solar pump, into a 10,000-litre storage tank. This tank has a pumping capacity of 3,000 litres per hour and provides free water to approximately 50 local families. From inception to implementation, the project timeline ran for a total of 6 weeks. The water tank is now managed by the local community and requires minimal external support.

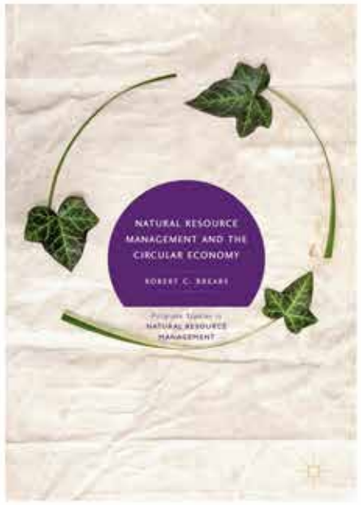
Lessons learnt

This small-scale project serves as evidence that community-led projects, with basic yet nascent technology and one-time funding, can be highly effective in meeting community water needs immediately. Moreover, community-led initiatives' success suggests that large-scale public or private sector investments and interventions are not always necessary.

Conclusion

To conclude this article, five key conclusions and lessons are drawn upon.

1. The success of water privatisation cannot be blueprinted or generalised. Successful water privatisation is dependent on local sensitivities as well as the endogenous factors of the water private water company. Given the proven advantages of water privatisation in some contexts (such as in Manila), if we reject water privatisation outright, we may deprive the public of a valuable service.
2. Water is a highly political and contentious topic. When decision-making around water does not include the views and opinions of citizens (hence depriving citizens of participatory parity), problems around water privatisation are more likely to occur.
3. It cannot be assumed that the private sector will succeed where the public sector fails. Instead, hybrid institutions could be considered.
4. While policies may appear to meet the needs of beneficiaries on paper, there is often a disjuncture between policies, practices and their intended outcomes. Policymakers and practitioners should oversee the entire project lifecycle, from design to implementation to evaluation. Assumptions about perceived success should not be made without following this process because there may arise a risk of reinforcing the very inequalities that the project set out to address.
5. Small-scale community-led water initiatives may prove highly effective in meet citizens' water needs in the absence of both the private sector and public entities.



Robert C. Brears

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This book provides insight into how governments are using a variety of innovative fiscal and non-fiscal instruments to develop circular economies with significant economic and environmental benefits. It emphasises the urgent need for these circular economies and to move away from our current, linear model that has led to environmental degradation, volatility of resource prices and supply risks from uneven distribution of natural resources. Natural Resource Management and the Circular Economyillustrates how governments havepromoted the development of an economy that can provide substantial net material savings; mitigate price volatility and supply risks; and improve ecosystem health and long-term resilience of the economy. Through a series of case studies, it details the various innovative policy instruments which can be utilised, including regulations; market-based instruments; incentives; research and innovation support; information exchanges; and support for voluntary approaches. The book also proposes a series of best practices for different countries, both developed and developing, who are implementing their circular economy.

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NATURAL RESOURCE
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ROBERT C. BREARS
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Climate Resilient Urban Areas: Governance, Design and Development in Coastal Delta Cities

By Rutger de Graaf-van Dinther

Cities in particular are vulnerable to climate change impacts. With more than half of the global population currently living in cities, climate change already has a profound impact on society. Climate change is increasing demonstrated in the number of extreme weather events across the world, most profoundly impacting urban regions. Given the current and expected climate impacts in urban areas, cities have started initiatives to respond to these threats. Significant advances have been made in the fields of urban climate adaptation policy, research, and practice and global networks for capacity building and knowledge exchange have emerged.

The idea for this book on climate resilient urban areas emerged in 2019 when I wrote a short opinion article about the four capacities to increase the climate resilience of urban areas. This article was based on my PhD thesis Innovations in urban water management to reduce the vulnerability of cities which I published in 2009 at Delft University of Technology. The four capacities are: threshold capacity, coping capacity, recovery capacity and adaptive capacity.

Following the publication of my opinion article, Henk Ovink, the Special Envoy for International Water Affairs at Kingdom of the Netherlands, suggested to add a fifth component: transformative capacity. In the same week, Robert C. Brears, Series Editor of Climate Resilient Societies informed me about the potential opportunity to coordinate a book on climate resilient urban areas with Palgrave MacMillan. This is how the 2 years process of developing the outline of the book, inviting chapter authors, the writing and editing, started.

Climate resilience in urban areas is defined in this book as consisting of 5 pillars: threshold capacity, coping capacity, recovery capacity, adaptive capacity, and transformative capacity.

1. *Threshold capacity*: the capability to prevent damage by constructing a threshold against environmental variation, for example by construction a flood levee.
2. *Coping capacity*: the capability to deal with extreme weather conditions and reduce damage during such conditions.

RESILIENT URBAN CENTRES

3. *Recovery capacity*: capability to bounce back to a state equal to, or even better than, before the extreme event.
4. *Adaptive capacity*: capability to anticipate uncertain future developments.
5. *Transformative capacity*: the capability to create an enabling environment, strengthen stakeholder capacities, and identify and implement catalysing interventions to transition proactively to a climate-resilient society.

This framework is used as an integrative concept throughout the chapters. Resilience is an intrinsically inclusive and holistic concept that includes various themes, for instance technical resilience against natural hazards such as floods, droughts, and other extreme weather events. It also has strong social and governance dimensions, such as the presence and strength of neighbourhood social assistance networks in the event of disasters and stakeholders' capacity to innovate their working practice, enabling the transformation of their city. For coastal cities, the challenge of the resilience journey means utilising scientific knowledge, but also the knowledge of citizens, indigenous peoples, and practitioners. Measures and strategies on different scales are needed from national scale all the way down to neighbourhood, street, and building level. In some cases, optimising the existing urban infrastructure might be sufficient. More often, a transformation of the urban governance system is needed: resilience is by its essence systemic, and resilience interventions are also systemic. The systems level of impact often is not met with a suitable governance (formal and informal) system. To develop transformative interventions, this means creating soft spaces for transformation. For implementation and operations, this implies system changes in governance, collaborative models, and coalitions. The potential of innovative pilots to improve, replicate, and scale up is a key factor for transformative change. This book includes insights on different scales from areas of expertise such as engineering, social sciences, and urban design. Besides scientists from different fields, leading practitioners working in various global coastal cities have contributed to the book. Many of the book contributions are from the Netherlands, a country that is already partly located below sea level and that has centuries of experience of living with the threat of water. However, the book includes many examples and experiences and insights from coastal cities all over the world to present a global perspective.

Figure 1. Floating Pavilion in Rotterdam the Netherlands: example of a climate resilient innovation in a former port area (Source: Rutger de Graaf-van Dinther; Photo: René de Wit)

The different chapters in this book demonstrate that we are in a transition in how urban areas respond to climate threats and internal social dynamics. The size and urgency of climate impact is such that adaptation is no longer considered sufficient. Instead, transformation of the entire urban system is needed to anticipate on climate change impacts. For this purpose, four key elements can be extracted from the book.

1) *Implementing innovations at appropriate scale and speed*: system wide impact of innovations on an urban scale and global scale requires application at an appropriate scale and speed which is relevant compared to the magnitude and severity of urban climate change impacts.
2) *Planning and collaboration*: Inclusive transdisciplinary planning with local communities and experts is needed to mobilize the required local knowledge and support for the climate resilient transformation process.
3) *Capacity building at a local level*: Transformative climate resilience is characterised by community based local urban systems. Citizen empowerment and capacity building among local stakeholders are crucial success factors
4) *From sustainability to regeneration*: Urban development and redevelopment processes contribute to restore damaged ecosystems, by providing habitat and linkages to other nature areas.

Building transformative capacity is not only about changing water management but also about changing urban development and urban redevelopment practice. One of the ideas proposed in the book is to create Floating Communities as a climate resilient testing and learning environment for new transformative societal models to contribute to the transition to climate resilient urban areas.

The book is available here

*Rutger de Graaf-van Dinther is Applied Research Professor of Water Innovation at Rotterdam University of Applied Sciences, the Netherlands, and director/ founding partner of three water innovation companies: DeltaSync, Blue21 and Indymo.

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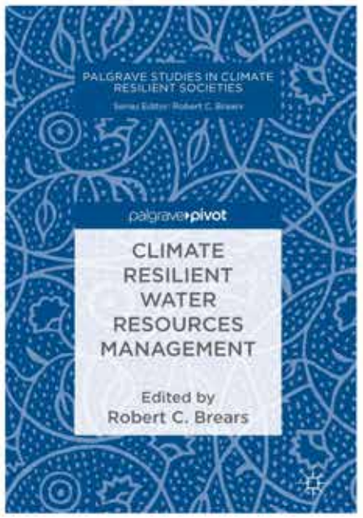

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Robert C. Brears (Ed.)

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- Discusses how governments can implement climate resilience strategies whilst protecting the natural system
- Argues for adaptable climate resilient water resources management
- Lays out the effects climate change has had on water quantity and quality

The effects of climate change are beginning to impact water quantity and water quality across the globe. However, there is no single action or strategy that any government can implement to ensure a community is resilient to climate change-related extreme weather events while also protecting the natural system. Instead, Robert Brears argues, climate resilient water resources management requires integrated, forward-thinking policies that are not only adaptable to changing climatic conditions but also seek to maximise economic and social welfare in an equitable manner while ensuring the continued health of their ecosystems. This book addresses how several levels of government in different geographical locations, with varying climates, incomes, and lifestyles, have implemented a variety of policies and technologies to ensure communities are resilient to climatic risks, and how these policies preserve and enhance the natural system and its associated ecosystem's health.

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CLIMATE RESILIENT WATER RESOURCES MANAGEMENT

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Robert C. Brears

Build Back Better: The Critical Role of Water-Smart Cities

By Will Sarni and Robert C. Brears

Last century public policies and technologies are no longer adequate to ensure water for economic development, business growth, social well-being, and ecosystem health. The water sector faces multiple threats which have become acute because of the pandemic. Water scarcity is driven by increased demand and poor public policies. Poor water quality results from poor public policies (think: lead poisoning in Flint, Michigan), ongoing contamination (think: nutrient loading from non-point sources) and ageing and underfunded infrastructure. Climate change only exacerbates these water scarcity and quality trends.

The pandemic revealed the fragility of our water infrastructure and accelerated interest and adoption of digital technologies. We are now witnessing the scaling of digital (smart) technologies for water and wastewater utilities, homes, communities, and cities. The water sector's digital transformation was well underway in 2019 and has significantly increased over the past several months. Water and wastewater utility sectors are now exploring and deploying digital technologies to manage infrastructure assets, remotely monitor water quality within watersheds, support workforce augmentation, and monitor COVID-19 in wastewater.

Not only are water and wastewater utilities adopting digital technologies. The emergence of digital water technologies in homes and communities enables more localized water and wastewater treatment systems. The convergence of digital technology adoption by the water and wastewater sector, homes and cities will foster more sustainable and resilient cities when faced with increased demand and "black swan" events such as a pandemic.

Smart water policies

With water resources facing multiple challenges, there is a need to move towards smart water policies that ensure good quality water of sufficient quantity for all users, both human and natural. Smart water policies need to be centred around demand management.

WATER-SMART CITIES

Traditionally, urban water managers, faced with increasing demand for water alongside varying levels of supplies, have relied on large-scale, supply-side infrastructural projects, such as dams and reservoirs, to meet increased demands for water. However, this supply-side approach is under increasing pressure from climate change, rapid population, economic growth, and even land-use changes impacting the availability of good quality water of sufficient quantities. To ensure adequate water supplies, water managers are turning towards demand-side management which aims to improve the provisions of existing water supplies before new supplies are developed. There are two types of policy tools available to achieve urban water security: fiscal tools and non-fiscal tools.

Fiscal tools include water pricing and subsidies and rebates to modify water users' behaviour in a predictable, cost-effective way. Urban water managers typically price water using increasing block tariff rates, which contain different prices for two or more pre-specified quantities (blocks) of water, with the price increasing with each successive block. Urban water managers can also use two-part tariff systems, which contain a fixed charge and variable charge. Subsidies and rebates meanwhile are used to encourage water users to make sustainable consumption choices. For instance, subsidies are commonly used to encourage the uptake of water-saving devices and water-efficient appliances or technologies. In contrast, rebates are commonly used to accelerate the replacement of old water-using fixtures and appliances. Overall, positive incentives are found to be more effective than disincentives in promoting water conservation. Examples of fiscal policy tools to encourage water conservation and water efficiency include: the San Francisco Public Utilities Commission offers rebates for various domestic and non-domestic appliance and equipment upgrades and Singapore's Public Utilities Board revised its water prices upwards in two phases to meet future demand while delivering a high quality and reliable water supply.

Urban water managers can also rely on a range of non-fiscal tools to ensure adequate supplies, including regulations and education and public awareness. Regulations often used include permanent and temporary ordinances that restrict certain types of water use during specified times and/or restrict the level of water use to a specific amount. Temporary and permanent ordinances are often used for various purposes, including restricting water levels during droughts, and ensuring new developments and renovations implement water-efficient fixtures and appliances. Meanwhile, education and public awareness are essential to understanding water scarcity and creating the acceptance of the need to implement water conservation programmes. Examples of non-fiscal tools to encourage the wise use of water include: The City of Boston has enacted its Building Energy Reporting and Disclosure Ordinance that requires the city's medium- and large-sized buildings to report their annual energy and water use and Scottish Water is developing a series of games for children to understand the water cycle and understand the importance of water efficiency.

Digitalization of water

The digital transformation of water is well framed in the World Economic Forum Harnessing the Fourth Industrial Revolution for Water report. It is just one more aspect of society that has transformed because of digital advancements. These technologies are everywhere: in transportation through services such as mobility on demand and micro-mobility, in healthcare in the form of digital record keeping and robotics, in education where digital readers, tablets and gamification are used to teach, and in the power sector in the form of smart devices and advanced analytics for optimizing network flows. Several recent reports highlight the ongoing digital transformation of water, including the International Water Association and Xylem publication Digital Water: Industry Leaders Chart the Digital Transformation, as well as the report Accelerating the Digital Water Utility, which is focused on the water and wastewater utility sector and geographically focused digital water technology solutions.

The applications of digital technologies for water and wastewater utilities are increasing. Digital technologies are being used across the digital water value chain from the watershed, utility operations and connecting to the customer and consumer.
The primary focus of digital water technology applications has been in managing infrastructure assets. Digital technologies are now used to:

- Identify leaks in pipes through satellite data and analytics (for example, Utilis)
- Monitor and predict treatment membrane performance using artificial intelligence (for example, Plutoshift).
- Support the workforce with access to asset construction information (for example, Redeye)
- Conduct real-time monitoring of stormwater sewer system (for example, Smartcover)

We can also provide wastewater network intelligence that visualises, analyses, predicts, and pinpoints network behaviour upstream (for example, Kando). A complete suite of digital technology solutions is available to monitor asset performance and quickly react or predict system failure.

Digital water technology applications are not confined to managing utility assets through sensors and water use monitoring through smart meters. Digital applications now include the use of satellite data and analytics to monitor water quality within source areas (Gybe), flood prediction (Cloud to Street) and to vastly improve connectivity to the consumer and customers (Water Smart and dropcountr). The application of digital technologies to build more sustainable and resilient water infrastructure is also scaling in parallel with the move to smart water homes. Systems that monitor real-time lead concentrations at the tap (spout), smart tap filters (TAPP Water), along with leak detection in home plumbing (Conservation Labs) are being deployed.

Digital technologies enable a shift from exclusively centralized water systems to localized (distributed and decentralized) systems. This includes innovative water supply systems such as air moisture capture (Zero Mass Water and Water-Gen) and small-scale treatment systems (Organica and Aqwise). As we have seen in the energy sector, small scale localized systems such as solar are more resilient to extreme weather events. Smart water utilities and homes make the reality of water-smart cities within our reach.

Conclusion

The pandemic has raised the question of whether there will be an exodus from major global cities. For us, regardless of the outcomes, cities of all sizes and locations have an opportunity to rethink public policies, infrastructure, and technologies to be more resilient and sustainable. Innovation in public policy and the adoption of digital technologies will create truly smart cities. Smart policies and digitally intelligent cities will be better capable of responding to black swan events such as pandemics, extreme weather events, and growth strains. The time is now to chart a course for water-smart cities to ensure we can deliver water for economic development, business growth, social well-being, and ecosystem growth. We must build back better.

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SERIES EDITOR

Robert C. Brears is the founder of Our Future Water, Mitidaption, Mark and Focus, and is a Director on the International Board of the Indo Global Chamber of Commerce, Industries and Agriculture.

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The *Palgrave Studies in Climate Resilient Societies* series provides readers with an understanding of what the terms resilience and climate resilient societies mean; the best practices and lessons learnt from various governments, in both non-OECD and OECD countries, implementing climate resilience policies (in other words what is 'desirable' or 'undesirable' when building climate resilient societies); an understanding of what a resilient society potentially looks like; knowledge of when resilience building requires slow transitions or rapid transformations; and knowledge on how governments can create coherent, forward-looking and flexible policy innovations to build climate resilient societies that: support the conservation of ecosystems; promote the sustainable use of natural resources; encourage sustainable practices and management systems; develop resilient and inclusive communities; ensure economic growth; and protect health and livelihoods from climatic extremes.

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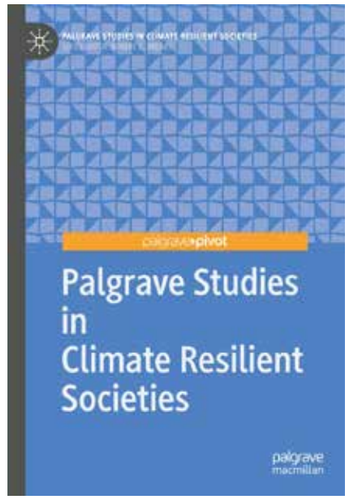

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ZLD Technology Disruptor: Carrier Gas Extraction

By Mr. Ravichandran Selvaraj
Managing Director, Gradiant India (P) Limited

In their endeavour to meet regulatory norms, sustainability objectives, and corporate governance goals, industries across India are beginning to explore and adopt Zero Liquid Discharge (ZLD) standards at their treatment plants. They no longer consider wastewater treatment a liability but a key resource recovery system.

In India, water use efficiency - a ratio of water withdrawal to discharge volumes, is not monitored in industries, but with growing consumer pressure for freshwater and scarcity issues, water as a resource simply cannot be used once in the manufacturing processes and discharged.

By leveraging the circular economy principle, Zero Liquid Discharge aims to close critical water loops and foster reuse over continuous cycles through extended treatment.

ZLD implementation

At present, industrial sectors, including textile, pharma, pulp and paper, chemical, power, dye and dye-intermediates, steel, and fertilizer industries, have implemented ZLD based on mandates from state pollution control boards. Currently, ZLD implementation in the country comes from judicial orders and statutory mandates from state pollution control boards based on factors such as

- Classification of the industry - Grossly Polluting Industry (GPI)
- Water consumption and discharge rates at the industry
- Auxiliary chemical usage in the manufacturing process
- Challenge in the conveyance of treated effluent for discharge
- Impact on the immediate environment due to discharge
- Water scarcity issues in the immediate environment

Thus, as India grips with water security issues, ZLD is rapidly becoming a norm for industries to address through regulatory statutes and drive to reuse treated wastewater.

Mark and Focus

ZERO LIQUID DISCHARGE

Reject Management systems

Of the several factors to consider while installing a ZLD system at a facility, one performance parameters standing tall is CAPEX and OPEX considerations is Brine Management.

Brine management of effluent takes up close to 50 % in CAPEX of any potential ZLD project. Thus, an evaporator system addressing brine management can make or break the operations. Additionally, reject management systems also weigh heavily in OPEX due to dependence on the constant running of utilities such as power and steam. Moreover, the evaporators currently available in the market rely on dated legacy solutions and complex system architecture.

Gradiant's Carrier Gas Extraction (CGE) system is a proprietary humidification and dehumidification (HDH) based thermal evaporator system that incorporates carrier gas to cause a phase change of feed water from liquid to vapour. The CGE system reimagines the conventional evaporator based on product innovation to suit a wide range of industries. Some of the key benefits that a CGE system possesses that sets it apart from legacy evaporators are

- The direct phase change from liquid to vapour, unlike conventional systems
- Operates at ambient pressure instead of vacuum pressure
- Ease in overcoming scaling issues without major stoppages of the plant

The advantages and leap in the operating philosophy of the CGE system are made possible by mimicking the humidification and dehumidification operations of the natural rain cycle. Additionally, this principle is translated to an industrial scale process with the help of novel bubble column architecture, ensuring minimal rotating parts and an easy to operate system.

A prominent textile processing firm in Tirupur, Tamil Nadu (the textile processing capital of India), while looking for an innovative and comprehensive ZLD solution, engaged with Gradiant to procure a Carrier Gas Extraction (CGE) based system to alleviate their challenging effluent handling needs. The project showcased is the country's first CGE based ZLD system that is commercially scaled and operated successfully for over a year.

Gradiant designed a system comprising of the CGE, crystallizer, pusher centrifuge and an agitated thin film dryer to effectively handle 200 m3/day of textile processing effluent with a feed TDS of 55,000 ppm. Furthermore, the project's scope includes the design, engineering, construction, erection & commissioning, and operation and maintenance of the ZLD system.

At the outlet of the treatment train, the system recovers freshwater of TDS less than 50 ppm, hardness less than 50 ppm, pH between 6 – 6.5, colourless than 100 on the platinum cobalt scale. Additionally, close to 1.2 tons of salt is recovered per day. The Glauber's salt recovered is reused by the dyeing process of the textile mill.

Figure 1 A typical CGE system at an Indian textile processing mill - Humidifier & De-humidifier columns along with pump skids

How does it work?

While achieving performance metrics of salt concentration and freshwater recovery compared to other legacy evaporator systems, the CGE, with the difference in operation ensures minimal maintenance and downtimes.

With the placement of heat exchanger outside the main installation, the CGE system minimizes scaling inside CGE towers, overcoming scaling issues while maintaining efficiency and extending the minimal cleaning cycles. A single-pass via CGE system, as shown in Figure 2 and 3, would constitute the feed wastewater entering via the heat exchanger, which then is passed over to the humidifier column, where carrier gas, usually ambient air, is introduced into the system through an air blower. Due to the gradient in concentration and temperature, the air is heated and transfers freshwater as a vapour to the de-humidifier column, with concentrated waste being phased out of the system.

With the passage of humid air through the proprietary multistage bubble column and the exposure to cycled cool water, freshwater is recovered, and heat supplied is also recovered.

This phase change of feed water from liquid to vapour, including the recovery of freshwater, happens seamlessly. Moreover, there is a decoupling of the surface of heat transfer and phase change from liquid to vapour. This results in increased efficiency of the overall system as typically scaling largely occurs in evaporators due to heat transfer. With the decoupling in the CGE system, Cleaning-in-Place (CIP) protocols are greatly reduced.

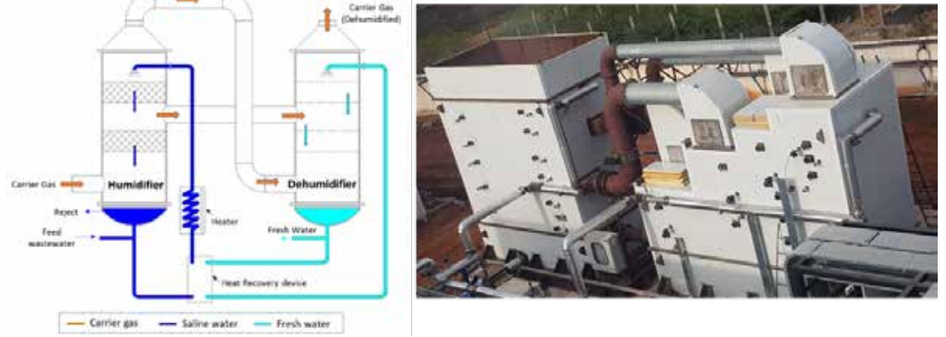

Figure 2 CGE indicative against actual installation

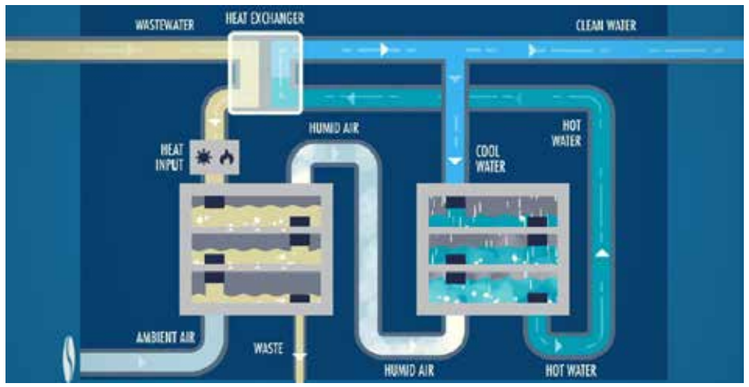

Figure 3 Carrier Gas Extraction process schematic

ZERO LIQUID DISCHARGE

These benefits, when translated to site conditions, results in maximum uptime for the CGE system. In contrast to legacy systems, the heat exchanger (twice a month) and humidifiers (once a month) can be easily cleaned. Additionally, the cumbersome process of hydro jetting-based cleaning is not required due to the innate differences in the operation of the CGE in overcoming scaling.

In conclusion, as ZLD norms are getting notified by more statutory bodies across the country for varying industries, there is a requisite of benchmarking currently available technologies to address the normative needs of end-user for economical operation and passed on benefits of ZLD to the environment. The CGE system developed by Gradiant provides avenues as a technology disruptor in this niche space of wastewater treatment with proven commercial scaling in India and abroad.

About Gradiant India (P) Limited

Gradiant has its Indian headquarters in Chennai, with capabilities in Design, Research, Process, Engineering, Project Execution and O&M. Operations is supported by an in-house lab facility. The sales & marketing team operates from Chennai, Coimbatore, Pune, and New Delhi. Gradiant India's Managing Director, Mr S. Ravichandran, has over 30 years of experience in the water & wastewater industry. Prior to Gradiant, he worked at various multinational organizations such as Nalco, Ecolab, Praj Industries, and Ion Exchange. At Gradiant, he brings his wealth of knowledge and understanding of the Indian and international wastewater landscape to the forefront. He has built a 50 member strong team that backs him. Gradiant India is focused on its vision of enabling industrial growth in harmony with nature.

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Mark and Focus

Building a New World: Post-COVID-19