

A composite image showing the Chicago skyline in the background and a lush green park with a winding river in the foreground. The river has several small islands and walkways. A modern, white, curved structure is visible in the lower part of the park.

TRANSBOUNDARY WATERS

PRACTITIONER BRIEFING SERIES

Issue 10

Water and Urban Development

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Introduction

Natural disasters have wreaked havoc across the globe in recent years, often threatening densely populated areas. A series of severe droughts and heatwaves since 2014 have caused thousands of early deaths, forest fires, destroyed crops, the disruption of shipping traffic and complications with the cooling of nuclear power stations in Europe. The spells of heat and drought were the most extreme in more than 2,000 years. In Australia the 2019-2020 bushfires affected close to 80% of Australians either directly or indirectly, with over 3,000 homes and 7,000 facilities and buildings destroyed and 12.6 million hectares burned. "The unprecedented ferocity of this fire season has traumatized Australia. These deeper concerns have been called 'collective trauma'", said a researcher in a study on the impact of the bushfires on urban settlements: "it exposes Australians to reconsider how we live." [1] [2]

This sense of unpreparedness was also felt in the United States where the 2021 Texas winter storm left millions without electricity for days, in freezing temperatures. In February, a deviation of -28 C (-50 F) compared to the normal average temperature at that time of year was recorded in the state. "The extreme weather events that we're experiencing this week ... do yet again demonstrate to us that climate change is real and it's happening now, and we're not adequately prepared for it," White House homeland security adviser Liz Sherwood-Randall told reporters at a briefing. [3]



Source: Iwona Castiello d'Antonio / Unsplash

Shared Approach:

City networks, a shared approach to sustainable urban development and integrated water management

Climate change related disasters have put sustainable development at the top of the agenda of governments around the world, with cities playing an increasingly important role. With the unprecedented growth of cities around the world in recent decades, cities not only have a greater responsibility but also a greater voice in the international debate on sustainability and the protection of natural resources. Because city governments are closer to the local population, they are usually more aware of local problems than their national government counterparts. Moreover, due to their size and economic capacities, cities are not only a major cause of pollution and depletion but also an important pillar in solving these cross-border problems.

A number of promising projects in the field of water sensitive urban design and 'greening' of urban areas show what the city of the future could look like. A city that is reconnected to natural ecosystems and where wastewater is as precious a resource as the water itself.

In this briefing we take a closer look at some of those projects, and explore the dynamics between local and national governments in the field of urban sustainable development and climate resilience, and their interaction on the international stage. We also look at approaches and technologies that cities can use to make urban water and wastewater processes more sustainable, make the urban landscape more resilient to climate-related crises, and meet the increasing demand for water while also limiting their transboundary impact.

Practical Summary

- Due to the extraordinary expansion of cities in the past decades, and the increasing diversification of water uses, governments are struggling to meet urban water demands. At the same time, city leaders have become increasingly aware of the transboundary impact of urban development and urban life on the surrounding countryside, the river basin and beyond national borders.
- Climate change and erratic weather patterns make cities more vulnerable to heat, drought or floods. Due to the high population density in cities, relatively large numbers of people are at risk of such disasters.
- Cities and transnational city networks have been at the forefront of combating climate change, sustainable development and water management, at times when national governments were slow to respond. Despite this, cities have not yet received the recognition they believe they deserve at international summits.
- Rapid urban development turned cities into 'hard environments'. Cities became disconnected from the natural water cycle, due to the construction of metal and concrete water and wastewater infrastructure, the canalization of rivers and the construction of asphalt roads and pavements.
- Integrated Urban Water Management focuses on relieving pressure on natural water resources through the reuse of treated wastewater, and promotes the restoration of the natural water cycle in urban areas by applying water sensitive engineering techniques and using natural features. Its integrated approach also allows cities to become more climate change resilient.
- For the success of projects in the field of water sensitive urban design and nature-based solutions, broad stakeholder input and participation processes are required. Such processes provide an impetus for fair allocation of water and green spaces to different population groups.

Urban Growth

We live in a unique era; for the first time in human history, more people live in cities than in rural areas. At the start of the 19th century, only 2% of the world's population lived in urban areas, increasing to 10% at the start of the 20th century. Large numbers of people moved from the countryside to the city in search of better opportunities. Population growth also took place in the cities themselves and the expanding cities swallowed up surrounding villages and communities. Due to this unprecedented growth, a remarkable milestone was reached in the first decade of the 21st century, with more than half of the world population living in cities and towns. By 2030, an estimated 60% of people worldwide will live in urban areas, with most of the urban growth taking place in low-income countries. The city has become the primary habitat of our species. Economic growth and social development are increasingly concentrated in cities and towns, while the countryside is often neglected. In the city, specialist know-how and complimentary services are available in the vicinity, which contributes to the production of goods and the enhancement of public services. The availability of these services, such as hospitals, libraries and universities, attracts residents from surrounding areas, who increasingly turn to the city for many of

their needs. Because of this, nearby villages gradually lose their facilities and shops, or are being swallowed up entirely by the encroaching city. This process of agglomeration further accelerates urban expansion. Due to the clustering of services and activities an estimated 80% of the world's gross domestic product is generated by cities. [4]

The downside of the unprecedented growth of urban areas is that many natural resources have come under increased pressure and water resources in particular are at risk of being depleted or irreversibly damaged. Within the city, water demand increases in tandem with population growth. Water is needed for consumption, sanitation, recreation, production and transportation and is used for parks and other green spaces. It is of key importance for the general well-being of city dwellers and the support of ecosystems. This competition between different water uses causes an ever-increasing demand for water, with the risk that more water will be pumped from natural sources than can be replenished.

Climate change puts even more pressure on natural resources, increasing the likelihood of heatwaves, prolonged drought or flooding. In recent years, more attention has been paid to urban development and planning policies that take into account extreme



Ahr river in Insul, flooded village 2021, Germany. Source: Shutterstock

weather conditions and address the vulnerability of electricity and water networks and food supply chains. With the explosive growth in the number of urban residents worldwide, governments around the world must seek to adapt existing neighborhoods, buildings and structures and think about what the city of the future should look like. For many, the future city is the circular city, in which waste becomes a resource and natural systems are regenerated.

Transboundary Impact

The current state of the city, however, is far from circular. Modern city life and the consumption patterns of city dwellers have an impact far beyond the city's limits, and across national borders. For the development of new buildings and infrastructure, raw materials are imported from other countries, and the energy needed to transfer these materials and build these structures is often generated from fossil fuels extracted elsewhere. Similarly, the city imports 'invisible' water, in the form of food and consumer goods produced elsewhere. In addition, due to their expansion and socioeconomic developments cities are now the source of 70% of global CO₂ emissions and two-thirds of the world's energy consumption, making them big contributors to climate change. But while these factors have implications for urban livability, the wider environment and natural

resources, it also makes cities unique places for change from which many of humanity's greatest challenges can be addressed. And because these problems are of a transboundary nature they also need much more of a transboundary approach. [5]

Towards Urban sustainability

Over the past 50 years, significant steps have been taken worldwide to make cities more sustainable and reduce the impact on their surroundings. In 1976 the United Nations General Assembly convened the Habitat I conference in Vancouver. With a considerable number of the urban population worldwide living in slums and squatter settlements, the main concerns of countries participating in the conference at the time were informal urban development, the growing disparity between rich and poor and unequal access to utilities and services, such as electricity, water and sanitation. The Secretary-General of the Conference, Enrique Peñalosa, stressed that, "the paramount question is whether urban growth will continue to be a spontaneous chaotic process or be planned to meet the needs of the communities". Countries were in desperate need of new and sustainable models for urban development. [6]

In the following decades, a gradual shift in thinking about human impact on the environment can be seen. Whereas the first Habitat report mainly mentions the availability and access to usable land and water as important factors for development, and the need to use them with due regard for the environment, much more emphasis was placed in subsequent conferences on actively promoting a healthy urban environment, combating climate change and the adoption and development of methods to conserve water and restore ecosystems. Habitat II advocates an “integrated approach to water resources management that takes cognizance of the links between water, sanitation and health, between the economy and the environment, and between cities and their hinterland, and harmonizes land-use planning and housing policies with water sector policies.” [7]

Habitat III produced the New Urban Agenda (NUA), with integrated approaches forming the backbone of strategies for sustainable urban development. Issued in 2016, it provides guidance for achieving the Sustainable Development Goals that were adopted the year before. There is a stronger focus on investments in and planning of sustainable infrastructure and service provision systems for water and sewage, and for making these systems climate resilient and integrated in other urban and territorial development plans. For the first time, the link between the city and the water cycle is highlighted, as well as specific strategies for rehabilitating water resources: “We commit ourselves to promoting the conservation and sustainable use of water by rehabilitating water resources within the urban, peri-urban and rural areas, reducing and treating wastewater, minimizing water losses, promoting water reuse and increasing water storage, retention and recharge, taking into consideration the water cycle.” [8]



The EU’s Urban Wastewater Directive (UWD) (1991), an agreement aimed at protecting the natural environment from urban wastewater effluents, has been instrumental in rehabilitating Europe’s water bodies, many of which are transboundary. In the UWD European countries agreed that wastewater should be collected and treated in urban agglomerations with a population of 2000 or more, with more advanced treatment in places with a population of 10,000 or more when discharged in “sensitive areas”, water bodies that have become vulnerable due to high nutrition loads. Among its main successes since its introduction 30 years ago, is that on average, nitrogen levels in aquatic environments have been cut by 32% while phosphorous concentration was reduced by 44%. The introduction of the UWD wastewater treatment standards and measures has had a significant impact on the quality of bathing waters in Europe and allowed the recovery of certain fish species in lakes and rivers. [9][10]

Role of Cities

Although important steps have been made, cities are still miles away from a true transformation. City leaders say that more can be achieved if they are acknowledged as equal negotiating partners in talks about urban sustainability at global conferences. And given the fact that the populations and economies of some of the world’s biggest metropolises are comparable to those of a small country, city leaders may have a valid point. Within UN Habitat, cities have attained a special status allowing them to take part in deliberative processes, without vote, but they have not managed to extend this status to the core organs of the UN. The Habitat I Vancouver Declaration stated that “governments must help local authorities to participate to a greater degree in national development”, and Habitat II promoted decentralization, closer ties between governments and local authorities and the importance of exchange between cities and their populations. [11]

But the first official draft of the New Urban Agenda did not explicitly mention what role city leaders might play when it comes to implementing the NUA, and at the onset of Habitat III, organizers received a wave of criticism from city leaders for not allowing them a seat at the negotiating table. (Although a group of 100 global city officials worked with member states as ‘consulting partners’ on the first draft of the NUA.) Cities were also effectively excluded from global

climate negotiations in Lima in 2014. It prompted leaders from 500 cities to issue a 10-point manifesto, calling for a “paradigm shift in global governance”, with stronger partnerships between local and national governments that recognize the “democratic legitimacy” of local authorities. [12] [13] [14]

Dissatisfied with the meager role given to cities in global talks, the mayors of Paris and Buenos Aires launched a campaign for city officials to influence the G-20. Since 2017, mayors and city representatives gather in the Urban 20, an event mirroring the G-20. Together, they compile an urban agenda to influence the priorities of the national leaders of the G-20. The top is organized by C40 Cities and United Cities and Local Governments (UCLG), two of the most influential city networks. The 2020 U-20 organized task forces to address three priority themes selected by the cities: “Circular, Carbon Neutral Economy;” “Nature-Based Urban Solutions;” and “Inclusive Prosperous communities. [15]

Over the years, cities have gradually increased their presence on the world stage. After concerted efforts from a coalition of local government networks, civil society organizations, and UN agencies, Sustainable Cities and Human Settlements was included in the 2030 Agenda as SDG11. Being the only goal with a specific sub-national focus, SDG11 is an unprecedented recognition of local governments in the international development agenda. The global importance of cities for grand challenges has been recognized in the Paris agreement on climate change and the UN Sendai Framework for Disaster Risk Reduction as well. [16] [17] [18]



Source: Shutterstock

Redesigning the Urban Landscape

Due to their expansion and increased population density, cities have not only become thirstier and more vulnerable to climate change, their impact on

their surroundings has also increased. Municipal and industrial wastewater, as well as storm water runoff from the city’s streets contaminate rivers, lakes and groundwater. As national and local governments are looking for new ways to protect the health of urban populations and promote socio-economic development without further environmental degradation, the role of the water sector is expanding.

In addition to providing water for the different needs of businesses and city dwellers, the sector is increasingly involved in redesigning the urban landscape and making the city resilient to water-related crises, such as drought, heat and flooding. As a result, it increasingly interfaces with other sectors, such as the energy, agriculture and environmental sectors. In recent years, experts and water professionals have therefore been looking to better integrate the different disciplines involved in the development of water and land.

Urban Water Management

Integrated Urban Water Management (IUWM)—the application of Integrated Water Resources Management (IWRM) principles at the city level—has emerged in the past two decades as a promising framework for sustainable urban development from a water perspective. IWRM can be defined as ‘*a process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital Ecosystems.*’ (Global Water Partnership). [19]

The main principles of IWRM revolve around an integrated approach to sustainable urban water development, both from an organizational and watershed perspective. IWRM promotes the coordinated development and management of natural resources and attempts to move away from thinking and operating in silos, where different sectors have their own set of goals and policies. Instead it advocates collaboration across disciplines, bringing together experts and professionals from various fields of expertise, from architects, planners and engineers to social scientists, for the design and planning of systems for water, sanitation and climate change resilience. Furthermore, to encourage the adoption of new policies and infrastructure, stakeholder input is of great importance, e.g.

input from local residents, local entrepreneurs, and representatives of different groups in society such as minorities, the elderly and people with disabilities.

IUWM looks at the impact of urban development on the watershed as a whole. Especially in developed countries, the natural water cycle has largely been replaced by a 'hard', engineered network of concrete and metal pipes, reservoirs and canals. These human interventions have affected the landscape in such a way that the natural water cycle has been interrupted at the evaporation, convection, precipitation and collection stage, both inside and far away from the city. Environmental scientists and water experts recommend introducing 'soft' green features into existing infrastructure in order to restore the natural water cycle where possible. According to these experts, the solution to urban water stress, degradation of ecosystems and climate-sensitive

areas can be achieved by 'closing the water loop'. To achieve this, IUWM strongly focuses on the treatment and reuse of different waste streams and the collection, treatment and controlled release of storm water into nearby water bodies for the infiltration of groundwater. Wastewater is regarded as a potential source of energy and nutrition within the IUWM framework and it therefore promotes decentralized and point source treatment of blackwater (wastewater from toilets) and greywater (wastewater from sinks, showers, washing machines, etc.). These all have different pollution loads and are best managed in semi- centralized systems in which treatment, reuse, and discharge take place at relatively short distances from where they are generated. Treated wastewater as well as nutrients derived from wastewater sludge can be used for agricultural purposes and for the irrigation of parks.

The main principles of IUWM are summarized by Global Water Partnership (GWP) in the 2017 IWM ToolBox:

Involving key players – at the planning, decision-making, implementation, monitoring, and evaluation stages is critical to the success of the IUWM plan. Roles and responsibilities must be clearly stated in a legal framework so that stakeholder participation happens in a structured manner.

Closing the “water loop” – that is, considering the entire water cycle as one, to the extent where the links between water sources, supply, wastewater, and storm water must be effectively understood and properly translated into actions. Bringing together the upstream and downstream relationships in the water cycle helps to provide a more holistic vision of urban water systems.

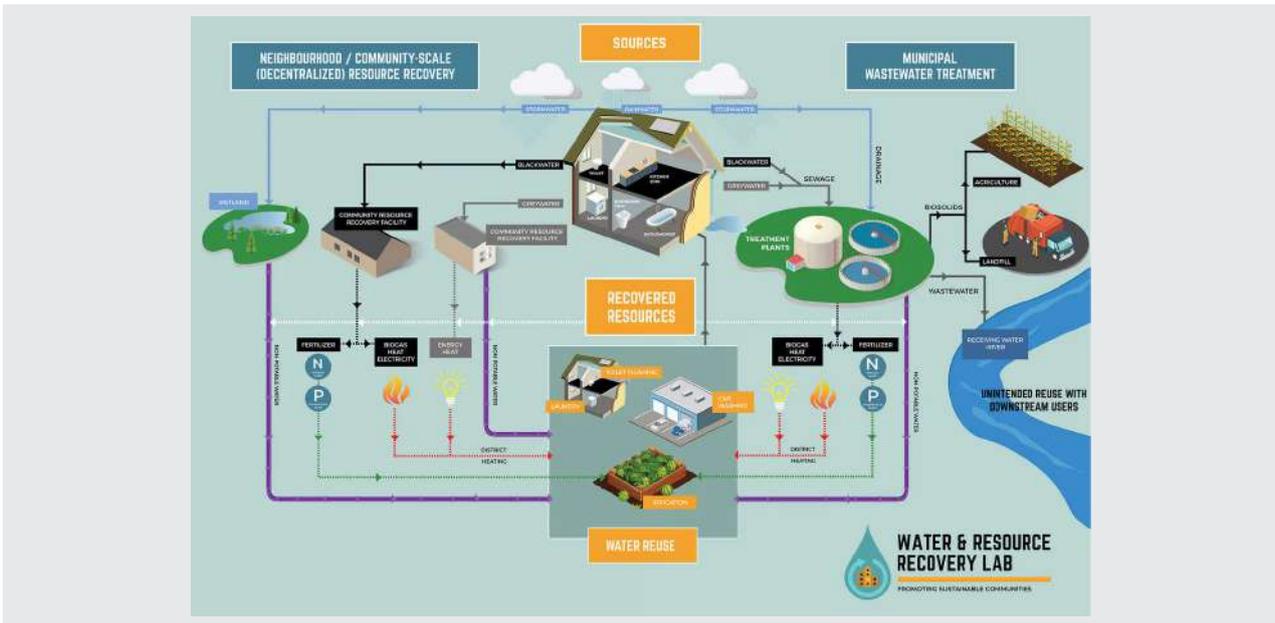
Assessing a portfolio of water sources – means to look into options for water sources that are traditionally less visible or simply less thought of. This includes, for instance, ground water, rain water, storm water, black water (wastewater), and grey water (wastewater that is not sewage, such as sink water and dishwasher discharge).

Waste as a resource – is to maximize the benefits from wastewater, which can be done by employing innovative technologies, so that water, energy, biogas, and nutrients can be actively reclaimed from wastewater. Recycling and reuse is central to improving the water efficiency in urban areas.

Designing adaptive mechanisms – within the IUWM strategy enhances resilience against uncertainty and changing conditions that are imposed by environmental disasters and global warming. Special attention should be given to integrated flood management in IUWM plans.

Urban water partnerships – can be established by involving academic institutions, media, and advocacy groups as well as industrialists and commercial actors. IUWM requires research and development for new water technologies just as much as it requires institutional actors to come on board and integrate principles of supply and demand efficiency in their daily usage of water.

Low cost, high impact solutions – are needed, especially for urban areas of developing countries.



Source: *Water & Resource Recovery Lab*

In addition, rainwater collection and retention allows for the strategic return of water into the water cycle, not only by replenishing ground and surface waters but also through the irrigation of trees and vegetation, which in turn release water through evapotranspiration. [20]

Water Sensitive Urban Design & Nature-based Solutions

Within IUWM, engineering principles from Water Sensitive Urban Design (WSUD) and a combination of natural blue and green features or nature-based solutions, are adopted to enhance existing infrastructure to enable it to mimic or restore the natural water cycle as much as possible. Combinations of 'grey' and 'blue-green' technologies are also used in mitigating and preventing climate related problems, such as floods, heat and drought.

WSUD focuses on adapting hard surfaces such as roads, roofs, driveways, pavement and squares to enable them to capture, treat and re-use storm water before it is discharged into nearby water bodies. Examples of features designed with WSUD principles are bioswales, water squares and permeable pavement. Nature-based solutions (NbS), also often referred to as blue-green systems, is a term to describe the use of natural features such as trees, plants, ponds and certain types of soil, rock or gravel for storm water management

purposes, drought mitigation, flood risk mitigation or water treatment. The terms 'water sensitive design', 'blue-green infrastructure' or systems and 'natural' or 'nature-based solutions' often overlap and are sometimes used to describe the same features. Blue-green infrastructure and nature-based solutions can be adopted at various levels of city planning: at the household or building level, for streets and housing blocks and -ideally- city-wide. The benefits of NbS are manifold and often mutually reinforcing. For example, trees cool their surroundings, including buildings, which helps bring down water and electricity use. Simultaneously, they help improve air quality and contribute to the retention of water, thereby reducing the risk of drought. In addition, NbS beautify the urban environment and contribute to the general wellbeing of city dwellers. From a management point of view, NbS are relatively easy to construct and maintain and maintenance costs are often low compared to traditional 'grey' infrastructure. For both WSUD and NbS, there are systems suitable for different climate conditions. GWP has released a practical manual, *Catalogue of Technologies for Integrated Urban Water Management*, with a wide range of different tools and systems for storm water management, water treatment and drought mitigation. A short overview of some of the more widely used systems is given below, with examples of projects where they have been successfully implemented. [21]

Water parks and squares

Flood risk mitigation, groundwater recharge and recreation can often go hand in hand, which can be clearly seen from the multifaceted, multifunctional spaces such as urban water parks and squares. Because these systems offer many different services, they are a common feature in cities with high precipitation or the occurrence of very powerful cloudbursts. There are many different variants, but the common denominators are the collection and then slow discharge of storm water and a space where people can meet and play. Often, techniques are included for filtering water as a first step for the removal of total suspended solids (small particles from asphalt, car tires, shoe soles, dust, etc.). Water squares or plazas often involve a combination of hard surfaces (pavement, road surface) and natural elements to promote water absorption. All blue-green (without grey) solutions are also common; these water parks support the ecological diversity in the city, improve air quality and contribute to the quality of life in the city.

Rotterdam's water square Betlehemplein combines three large storm water collection ponds which collect water from the pavement as well as the rooftops of surrounding buildings. Besides its hydraulic function, the square was intended to be a place where users from surrounding buildings could meet and interact. It can be used as an amphitheater and playground for basketball, football and skateboarding in dry times. The square is partly lined with pre-existing trees, which have been incorporated in the development plan and now form a green strip with various grasses and other plants. In keeping with the multi-functionality of the square, the water has also been given multiple functions and as a result is more visible to passers-by. For example, there is an open-air baptistery at the nearby church that also flows into the network of water channels. Water squares became official policy on an urban scale in the "Rotterdam Waterplan 2" in 2007. The square was opened to the public in 2013 and hailed as the 'first full-scale water square' in the world. Rotterdam is part of C40, a network of 97 cities around the world committed to addressing climate change. [22] [23] [24]



Water Square Betlehemplein, Source: de Urbanisten

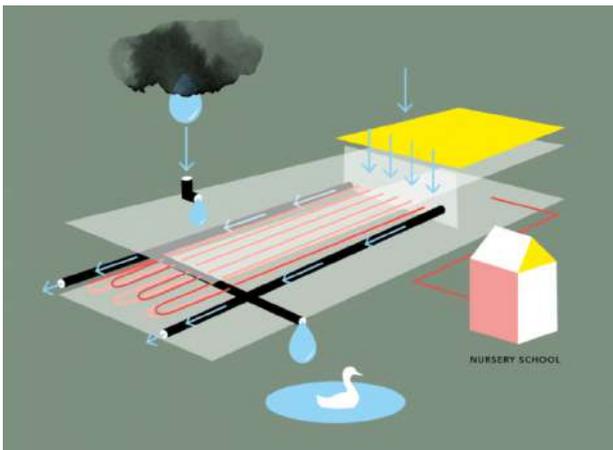
Bioswales

Bioswales are landscape features that collect polluted storm water runoff, soak it into the ground, and filter out pollution (such as silt and heavy metals). A typical bioswale is a long, linear strip of vegetation. They are designed to capture large volumes of runoff coming from big areas of impervious surfaces like streets and parking lots. Although they may look like normal flowerbeds or roadsides with abundant vegetation, they have more complicated design features such as layers of engineered soil and gravel, perforated pipe underdrains, and overflow structures to help drain large volumes of water from storms. For the construction of a bioswale it is best to select plants with a high absorption capacity to help prevent soil erosion. In some cases, check dams are built in the bioswale to further reduce water flow velocity. To ensure that bioswales are designed and built correctly, the expertise of an engineer and a landscape architect are needed. [25] [26]

In Stockholm's Ecodistrict a range of traditionally segregated structures are integrated to provide self-sufficient water, waste and energy services. Large-scale sustainable drainage systems harvest and filter wastewater and storm water in a park-like environment designed to boost the neighborhood's livability. Storm water is either discharged into the nearby lake or treated locally to optimize sewer capacity. Moreover, wastewater is made into a resource by a thermal plant that recovers waste heat from a sewage treatment plant.[27]

Permeable pavement

One of the more commonly applied techniques at street level as well as neighborhood level is the application of water-permeable surfaces instead of asphalt and interlocks, where possible. This is one of the many ways to slow down storm water that accumulates between buildings, with the advantage that the water is given the opportunity to infiltrate into the soil. This helps prevent streets, squares and basements from getting inundated and also enables the retention of water for a longer period of time, which is beneficial for plants and trees. Because the water flows away more gradually, the concentration of pollutants that is ultimately discharged in nearby water bodies is lower (compared to storm water runoff from roads and sidewalks).



Denmark permeable road, source: Foresight Climate & Energy

An interesting example where permeable paving has been applied is the C2C-CC project, a Danish Climate adaptation project across multiple municipalities partnering with wastewater and utility companies, universities and other actors in central Denmark. One aspect of the project, 'Infiltration of surface water through permeable coating' had the primary aim of rehabilitating the natural pre-development water cycle and flood prevention. It included the harvesting of rainwater in the roadbed which consisted of permeable asphalt, using a gravel mix to achieve a 30% porosity, capable of detaining the volume of water generated by a 100-year flood. The porous surface was used to remove pollutants from the water. The system also absorbed heat from the water it retained, and channeled it to a nearby day-care center through a geothermal tube. As such, this example of sustainable urban drainage technology provides flood control, water treatment, base-flow and sustainable energy. [28] [29] [30]

Green rooftops and facades

Rooftop gardens are a proven way of storm water management, using plants and trees to maximize the benefit of storm water that would otherwise be discharged directly onto the street below or into the storm water drainage system. The greenery helps to absorb rainwater, after which the water can slowly evaporate from the ground and the vegetation into the air. This process cools the environment and mitigates the effects of 'urban heat island'. The greenery contributes to improved air quality through the absorption of CO₂ and the release of oxygen. Rooftop gardens and green facades also cool the building, reducing water and electricity consumption of its residents. In addition, they serve as places for small-scale urban agriculture and provide shelter for insects and birds.



Augustenborg botanical roof garden, source: Green roof institute

Eco-city Augustenborg, Sweden

Augustenborg, a 40's/60's neighborhood in Malmö, Sweden, is home to 3,000 residents, containing 1,800 apartments. The neighborhood experienced substantial decline in the 70's and 80's. Houses suffered from energy inefficiency and inadequate drainage, causing seasonal flooding problems. Those who could afford it left, and the people who stayed behind were mainly people from low income groups, many of whom from immigrant backgrounds. The neighborhood needed an approach to lower tenancy turnover rates and stimulate economic activity, while making the houses more energy-efficient, flood-proof and green. To mitigate the effects of recurrent flooding,

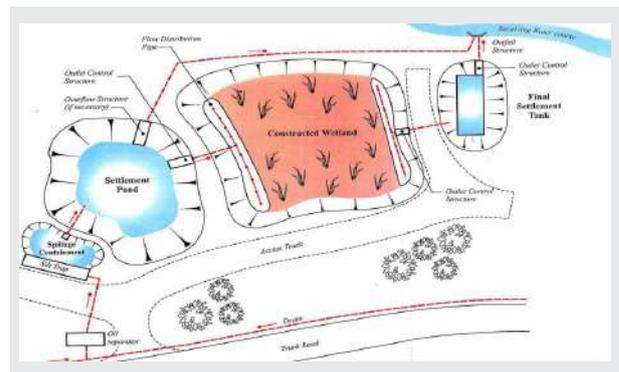
green rooftops and an integrated open storm water management system were built. The green roofs intercept half of the total runoff over the course of a year. A botanical roof garden covers 9,000 m² of the industrial area and was opened to the public in 2001 as the largest green roof in Scandinavia. In addition, a number of other houses and public buildings have a total of 2,100 m² of green roofs. With active engagement of residents throughout the planning processes, additional features were incorporated such as improved waste management, car-pooling, recycling and composting. Employment projects were also organized for local residents as part of the project.[31]

Room for the river

Another water management strategy in which the landscape plays an important role is to create space for the river to protect urban areas against flooding. In river deltas and lower-lying areas in particular, governments are increasingly applying policies that allow rivers to overflow their banks, instead of constructing higher embankments and repeated dredging of silted waterways. In the 'room for the river' approach, floodplains are expanded and additional overflow areas created that may be flooded during wet periods and provide space for recreation during dry periods. In order to partially return the river to its natural state, concrete quays are removed where possible and banks are planted with various reeds and other plants to improve biodiversity. This may mean that sometimes existing buildings are removed to make way for nature. [32]

Constructed wetlands

Constructed wetlands are man-made systems designed for the treatment of wastewater with a co-benefit of supporting flora and fauna. They are also referred to as reed beds due to vegetation that is typically used in these systems. Treatment methods with reed work in very low temperatures and can therefore be adopted in different climatic conditions, even with short term, sub-zero temperatures. Constructed wetlands have been developed for a wide variety of purposes, such as the treatment of municipal wastewater (including used toilet water), animal wastes, paper and pulp wastewater, wastes from olive mills and shrimp aquaculture and from the mining and metallurgic industries. Constructed wetlands can provide all mechanisms for wastewater treatment and achieve a comparable reduction in pollutant concentrations compared to more complex mechanical structures. One of the main advantages is their simplicity; because they don't need electricity, the running costs of wastewater treatment at a constructed wetland site is low compared to mechanical treatment facilities and they don't require much maintenance. [33][34]



Source: Environment Agency UK

Wider Adoption

Countries around the world are adapting their water and landscaping systems to provide adequate housing, water and sanitation to the increasing number of urban residents and protect them from climate change related crises. Although there is a growing awareness of the need to transform existing networks and infrastructure, and the technology and methods for sustainable urban management are available, cities have not turned into circular cities. What prevents cities from adopting these technologies more widely? And what are some of the pitfalls for cities that want to take urban sustainability to the next level?

Although technology for sustainable urban water management is widely available, it is not yet used in all levels of urban development. Not even in countries that play a leading role in climate change mitigation and sustainable development. Combinations of water-saving systems, renewable energy and wastewater treatment and reuse technology are mainly applied on a project basis, as a pilot study or test location on the street or housing block level. The green or circular city therefore seems far from within reach.

One of the major reasons for this is reluctance among decision makers to support new approaches and change practices and move from traditional 'hard' and 'grey' engineering solutions to 'soft' and 'blue' and 'green' strategies. It is suggested that institutional inertia and the inclination to stick to known strategies are the most important barriers. Lack of leadership and uncertainty regarding the distribution of tasks are also factors. For example, one of the core aspects of Integrated Water Resource Management is an integrated approach to water management issues, in which different disciplines work together in the field of water and urban development. But from an organizational perspective it is often unclear who should lead such a group of professionals and experts. [35] [36]

Novelty

A lack of knowledge may be one explanation for this. Although a large amount of international research has been done and literature is available, decision makers still regard blue-green systems as 'novel' and may perceive that it has not been sufficiently proven in practice. In addition, it can be difficult for them to see the long term, combined benefits (social, environmental and financial) of these systems, as they are very hard to quantify. [37]

Similarly, there may be a lack of awareness—and therefore support—around sustainable water management practices with the public. People unfamiliar with water management and climate change adaptation may not necessarily appreciate blue-green systems for their primary functionality, although they might support their implementation for other reasons, for example because green spaces make their city more beautiful and pleasant to live in. Also, people sometimes have preconceptions regarding sustainable tools and technology.

For example, a participant in an excursion to the eco-city of Augustenborg in Sweden said that "In Portugal (...) there is a widespread preconception that green roofs cause humidity problems in buildings." He also mentioned a possible solution: "Instead, the fact that green roofs are a weapon to tackle climate change and have many health advantages could be the turning point to change the Portuguese negative perception towards them."

Funding

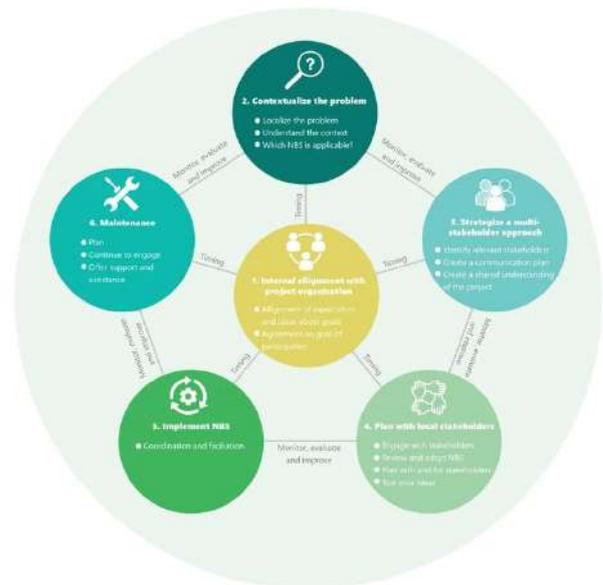
Another major barrier can be securing funding. Although natural systems for flood protection or wastewater treatment are often more cost-effective than conventional systems, to keep the systems operational over a longer period, longer term funding commitments are needed. Securing funding for ongoing maintenance can be impeded due to the fact that the multiple benefits of blue-green systems are difficult to translate into a cost-benefit analysis. However, in recent years new tools have been developed for cost-benefit analyses of NbS and SUD systems that help quantify and monetize the different benefits. Finally, whether funding should come from the central government, local government or the business community is also often a point of contention. A strategy that could contribute to creating more support from decision makers is a clearer identification of the many beneficiaries of the proposed sustainable solutions. By making it clear that a water square, such as the one in Rotterdam, not only offers advantages from a water management perspective, but is also beneficial for social cohesion, young people and the cultural sector, (financial) support can be garnered from departments and organizations outside the water and environmental domain. To better assess the various co-benefits at an early stage of the project, stakeholder involvement is of utmost importance.



Source: Asian Development Bank

Participatory Process

The early and broad involvement of stakeholders is key to enabling a wider implementation of sustainable urban development projects, not only to increase support within the governing system and secure funds but to provide an opportunity for input from all people that may benefit or be effected from a



Practical guide for participatory & socially inclusive NBS, Source: Nature4Cities

proposed project. According to GWP, the ‘ “rules of the game” indeed apply to everyone, private companies, NGOs, community-based organizations, women and disadvantaged groups as well as other sections of civil society should all be provided with genuine opportunities to actively participate in formulating these collective baselines. All these organizations and agencies have an important role to play as there exist many different perspectives on enhancing access to water, bringing about an equilibrium between conservation and development, and treating water as a social and economic good.’ It also brings about a sense of ownership and responsibility, which increases the likelihood that those involved will support and help maintain the blue green systems that have been introduced to their neighborhood. [38]

The involvement of local residents helps strengthen the social fabric in neighborhoods. Experts recommend that local city planners and project developers set up participatory processes, such as co-design or community-led schemes in which people from different backgrounds and with different perspectives and interests provide their input. In both Rotterdam and Malmo, participatory processes at an early stage of the project formed the basis for the design of the water square and eco-city and. As part of the design phase of the square, the participation was sought from teachers and students from adjacent schools, theatregoers, users of the gymnasium, members of the congregation of the nearby church

and residents from the neighborhood. The square is now a place that brings together people of different generations and cultural backgrounds. It also attracts people from outside the neighborhood, who would previously ignore this part of the city.

Unfortunately, city greening can also have undesirable implications. One of the pitfalls of transforming neighborhoods into eco-neighborhoods is that they increase social inequality. When project developers build properties with state-of-the-art water saving technology, re-use systems, solar panels and heat recovery mechanisms, they commonly target people with higher incomes who are looking for a home that matches their eco-lifestyle, and they are often willing to pay extra for these amenities. An influx of higher-income residents can boost the value of properties and make them unaffordable to other income groups, which may lead to a divide between the more and less privileged—often disproportionately affecting newcomers and immigrants. This was one of the criticisms to Stockholm's eco-district, where due to high property prices and rental fees, social mixing has been limited. Most residents are "upper middle class", according to an urban development researcher, adding: "It partly makes the area more homogeneous and at a Stockholm-level it contributes to making the city more segregated." [39]

When thoroughly implemented, participatory processes will contribute to integration and countering social inequality and in the long run, allow for equal access to water related services. The Augustenborg project in Malmo shows how water and nature can be used in the service of community building. Given the composition of the population in the district, with a relatively high percentage of residents with a non-native background and many people with low incomes and limited economic prospects, social integration was an important spearhead of the project. Residents played a fundamental part not only in re-designing their neighborhood but also in the process of shaping their community. About 20% of them joined in dialogue meetings. They also attended community workshops, and formal design information sessions. Some became more invested through volunteering and employment while the project developed. Their wider social and political involvement was reflected in the electoral turnout, which increased dramatically during the project: from 54% in 1998 to 79% in 2002.

City Networks

International partnerships between cities have existed for centuries. In the past, cities mainly established alliances in the field of trade and shipping, such as for example the Hanseatic League, an association of cities in Europe established between the 12th and 17th century. Nowadays, many different areas of knowledge transfer, cultural exchange and joint regulation exist between cities. In the past decades, the world has witnessed an explosive growth in city networks. Recent studies estimate that over 200 city networks operate at an international level today. At the turn of the century, cities began to play more important roles at the international level and became linked to some of the main global agendas. The increased influence of cities—and networks of cities—is creating a new dynamic on the global stage, with cities sometimes leading the way where national governments lag behind.[40]

Climate change and the environment are hot topics for transnational city collaboration, with many cities working together on projects related to energy, air

quality and waste. Because climate change and environment are cross-cutting issues related to virtually all other major themes, it is no surprise that many city-networks have developed initiatives in these two areas. Cities have to deal with many of the consequences of climate change and environmental degradation, and are often better informed about their impact on local populations, because they are closer to them than national governments.

The three most influential networks are UCLG, ICLEI and C40. The three often join forces in large projects, campaigns, and overarching networks related to local governance and sustainable development, such as The Global Taskforce of Local and Regional Governments and Cities Alliance.

In the following pages, an overview of some of the most prominent city networks, highlighted for their long track record, broad membership base and their focus on water management and water-related climate resilience, is presented.

Transnational City Networks, Local Governance Networks

C40

C40 Cities Climate Leadership Group is a network of almost 100 affiliated cities from around the world, representing 25% of the global economy and more than 650 million people. It was established in 2005, and is led by mayor of Los Angeles Eric Garcetti as chairperson and former mayor of New York City Michael Bloomberg as president of the board. The network promotes climate action on the municipal level, and works to close the governance gap between municipalities and national governments. In addition, it convenes the annual World Mayor's Summit, facilitates peer-to-peer knowledge exchange, and maintains the C40 knowledge hub with implementation guides, case studies and best practice examples on a range of topics including climate resilience, waste management and water security. [41]



C40 network

ICLEI

The ICLEI Local Governments for Sustainability network connects more than 1,500 cities and towns in 124 countries across the globe to work together on climate change and broader sustainability issues. Its activities are organized in 'interconnected pathways' (low emission, nature-based, equitable, resilient and circular development) to facilitate integrated sustainable urban development. Examples of its activities are the enabling of integrated urban water management through participatory catchment planning, decision making tools, preparation of catchment level action plans and multi-pronged financing to enable climate change adaptation measures in urban ecosystems of South Asia; and improving coordination and integration among African and European stakeholders active in water and climate initiatives, in the context of climate change resilience in different regions in Africa.[42]

Climate Alliance

Climate Alliance of European Cities with Indigenous Rainforest Peoples is a network committed to the protection of the world's climate, focusing mainly on the reduction of greenhouse gas emissions at their source. Its members are 1,700 cities and municipalities from 26 European countries, partnering with the Coordination of Indigenous Organisations of the nine neighboring countries of the Amazon Basin. Climate Alliance develops and coordinates campaigns and advises European cities and municipalities on the implementation of climate protection strategies and develops monitoring tools for energy consumption and CO2 emissions. It supports activities related to municipal water challenges and nature-based solutions. [43]

Asian Cities Climate Change Resilience Network

The ACCCRN started as a flagship project by the Rockefeller Foundation in 2008. It builds from lessons and experience of its eight-year program in four core-countries: India, Indonesia, Thailand, and Vietnam. Today, ACCCRN is a regional network operating in over 20 cities in 6 countries. It aims to influence urban agendas and generate practical examples of ways to build inclusive urban climate change resilient cities in fast urbanizing, low and middle income countries, by connecting professionals and communities across Asia. ACCCRN's resources database contains technical documents, resilience strategies, city studies, and policy briefs, as well as multimedia such as infographics and videos. [44][45]



ACCCRN network

United Cities and Local Governments

United Cities and Local Governments (UCLG) is an umbrella network in which cities, local and regional governments, as well as municipal associations from all over the world work together to defend the interests of local governments on the world stage. The organization focuses on increasing the role and influence of local government and its representative organizations in global governance. It promotes strengthening local self-government for more responsive and efficient services and decentralization of government in the interest of citizens. With 240,000 towns, cities, regions and metropolises in 140 countries, and over 175 associations, it is the largest organization of sub-national governments in the world. It runs campaigns to promote the interests of local and regional governments at the UN, hosts meetings for city, local and regional leaders and organizes capacity building activities for its members. [46]

Eurocities

EUROCITIES was founded in 1986 by six cities and grew out to become a network of mayors of almost 200 European local entities 35 years later. Together with ICLEI, EUROCITIES was selected by the EU Commission to lead the development of the Urban Water Agenda 2030, which addresses global challenges such as water scarcity, water pollution, and flood resilience. [47]

Mayor Networks

The Covenant of Mayors

The Covenant is a network of over 9,000 local and regional authorities across 57 countries in Europe, launched in 2008 by the European Commission to take local action to achieve and exceed the EU climate and energy targets. The initiative was extended in 2012 with the inclusion of Algeria, Egypt, Israel, Jordan, Lebanon, Morocco, Palestine and Tunisia through the "Cleaner Energy-Saving Mediterranean Cities" (CES-MED) program, and again in 2016 with the opening of the Covenant of Mayors Office for Sub-Saharan Africa. [48][49]



Global Covenant of Mayors for Climate & Energy logo

The Compact of Mayors

The Compact of Mayors is an agreement by city networks – and then by their members – with similar goals to those of the Covenant of Mayors, namely to undertake a transparent and supportive approach to reduce city-level emissions, to reduce vulnerability and to enhance resilience to climate change. The network was established in 2014, at the UN Secretary General's Climate Summit in New York City by the C40, ICLEI and UCLG, and endorsed by several UN bodies, including UN-Habitat. [50][51]

In June 2016, the Covenant of Mayors and the Compact of Mayors decided to join hands to become the "Global Covenant of Mayors for Climate and Energy", the largest movement of local governments committed to going beyond their own national climate and energy objectives. The Compact of Mayors and the Covenant of Mayors formally partnered to support voluntary city action. The Global Covenant of Mayors wants to tackle three key issues, in line with the UN Sustainable Development Goals and climate justice principles: climate change mitigation, adaptation to the adverse effects of climate change and universal access to secure, clean and affordable energy. [52]

Transnational Municipal Basin Networks

Union of Baltic Cities

The Union of Baltic Cities, a non-profit voluntary organization with committees organized around 7 key themes, celebrated its 30 years existence in September 2021. It was established in 1991 by 32 cities from Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Norway, Poland, Russia and Sweden and now has approximately 100 member cities. This network of municipalities was established after the fall of the Iron Curtain and the collapse of the Soviet-Union, at the start of a new political and economic era in Europe when trans-nationalization of municipalities was encouraged by the European Union, through funding arrangements that supported cooperative arrangements beyond nation states. The committee Sustainable Cities is responsible for the policy areas Integrated Urban Water Management, and Climate Change, among others. It facilitates capacity building for water management, hosts webinars about water management and climate adaptation and has launched the Baltic Smart Water Hub, a database for the exchange of practical solutions to common infrastructural or managerial challenges. [53]



Source: Shutterstock

Great Lakes and St. Lawrence Cities Initiative

The GLSLCI was established at the start of the millennium by the mayors of Chicago and Toronto as the first transnational cross border municipal network between the US and Canada. The network consists of more than 120 cities around the Lakes Superior, Michigan, Huron, Erie, and Ontario, which are connected to the Atlantic Ocean via the Saint Lawrence River. It is recognized as a non-profit organization in the US and registered as a corporation in Canada. The mayors work with local leaders, NGOs and the public to advocate stewardship of the lakes - including tackling pollution, containing invasive species and enhancing flood resilience. In addition to its basin activities, it also includes programs on sustainable urban development and climate change adaptation. Through the Green Cities Transforming Towards Sustainability (Green CiTTS) program, the GLSLCI provides information and financial support to member cities to switch to more sustainable practices. Furthermore, it has compiled an online 'best practices library', where tools, webinars and documents are shared that are relevant to municipal issues in the area. Examples are the Urban Heat Tool Kit, designed to help local governments reduce the effects of extreme heat on their communities; and a range of designs for water sensitive roads and pavement.

Overlap

The explosive growth of city networks over the past 20 years has made it difficult for newcomers to determine who they can best join. This is also a problem for governments, companies or NGOs looking for partnerships to realize their goals. Many networks active in the field of climate, environment and sustainability are similar and there is a huge overlap in their aspirations and activities. It is difficult to measure the benefits of membership in city networks and whether membership actually has an impact on intended sustainability or climate resilience goals, and if membership truly helps to increase the influence of member cities on national or international policies. Cities that are new to the scene sometimes simply choose to join as many networks as possible to enhance their image. A city-development practitioner in Cape Town expressed her doubts in her opinion piece in *Global Policy*: 'Are they filling a critical governance gap in the age of urbanization, diverting resources from core city-making work, or serving the agendas of sponsors in exchange for public relations exposure for cities and/or their leader?' [54] [55]

To ensure that cities use city networks to their and their residents' greatest benefit, it is important that they first make an assessment of what areas they would like to work on. The next step would be to identify existing city networks that focus on the same areas of interest and whether their members could be potential partners for long-term collaboration. With regard to water, many different networks are involved in WASH (water and sanitation) related projects. Many networks also share experiences and information about flood resilience. But when cities seek cooperation in the treatment and reuse of wastewater, or the water-energy-food nexus, there are far fewer options.

It can also be beneficial at this point to find out if a network offers twinning-programs in which cities are paired to learn from each other, and if it facilitates cross-boundary cooperation or primarily engages in the exchange of best practices between different members. Furthermore, cities who want to join a network need to determine whose agendas they need to influence and what they expect from their city-network membership. Finally, they should also consider what budget is available for participation in such networks, what the institutional capabilities are to support the alliances that come with networking and how much staff capacity is available for the development of joint projects.

When the right choice is made, cities may benefit from their city networks in various ways -depending on their level of commitment and input. After all, the strength of such networks is determined by the members' willingness to take action. The added value of working in urban networks is that it encourages mutual exchange and learning, structures lobbying efforts, and gives members access to higher spheres of influence. However perhaps the most important benefit is this: The multitude of examples they generate of successfully executed projects in the field of sustainable urban development and integrated urban water management reminds us that—despite the difficulties—the city of the future can be realized. [56]

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Sources for Further Learning

UN Habitat - New Urban Agenda

<https://uploads.habitat3.org/hb3/NUA-English.pdf>

GWP Catalogue of Technologies for Integrated Urban Water Management

<https://www.gwp.org/contentassets/d57b65ff36804dbcb6a8ff98abe8214a/catalogue-of-technologies-for-iuwm.pdf>

Climate Technology Center & Network - Climate Change Adaptation Technologies for Water - Bioswales

<https://www.ctc-n.org/sites/www.ctc-n.org/files/resources/bioswales.pdf>

UK Environment Agency - Wastewater and Rainwater Management in Urban Areas: A Role for Constructed Wetlands

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/964634/WITHDRAWN-Guidance-Manual-for-Constructed-Wetlands.pdf

World Bank Group - Integrating Green and Gray: Creating Next Generation Infrastructure

<https://openknowledge.worldbank.org/handle/10986/31430>

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- Issue 4 - The Water-Energy-Food Nexus
- Issue 5 - Water Cyber Security
- Issue 6 - Transboundary Dams
- Issue 7 - International Water Law
- Issue 8 - Gender and Transboundary Water
- Issue 9 - Transboundary Water Technology
- Issue 10- Water and Urban Development

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