Increasing extreme weather events and growing populations are challenging cities faced with droughts and floods, and pressuring local water supplies. Cities are taking preventative approaches to enable a future with clean water to drink and neighbourhoods safe from flooding.
The Chennai Water Restoration and Resilience Framework is designed to be scaleable in order to activate public, private, and community stakeholders in a joint effort to rapidly restore as many water bodies as possible. Currently, the project is restoring 210 publicly controlled water bodies in Chennai. Previously, almost a third of the sites were informal dumps, and now they are being transformed to collect stormwater and recharge groundwater. Ambitions are scaled in the project’s next phases to restore 460 water bodies, and subsequently 1,200+ more upstream from the city.

The framework was created by the municipality in coordination with other state departments, and works to assign clear roles and procedures to make the most of the participation of the various stakeholders. Ownership is clearly defined for each water body to ensure the responsibility of restoration. Technical expertise is drawn from researchers and engineers across government, academia, and NGOs. From which a customised and comprehensive restoration plan is created for each pond, involving both technical and physical improvements, engagement of the community and volunteers, as well as a maintenance and monitoring plan.

Chennai has the dual challenge of a high water stress and managing heavy rainfalls in a city that has experienced rapid urbanisation. In 2015, a 100 year rainfall event caused a tragic loss of life and the destruction of property valued at $20 billion.

This event spurred the creation of the Chennai Water Restoration and Resilience Framework to unify and scale the efforts of all organisations and citizens working on water body restoration, which will serve to prevent future flooding and recharge aquifers.

What has the city achieved?

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What are the co-benefits?

**Social:**
The restored water bodies will serve as a shared space for socialising and exercise for all citizens, including the most vulnerable in society. Some of the ponds are situated in economically disadvantaged neighbourhoods, and will also serve to improve their resiliency in extreme weather events.

**Health:**
Chennai has some of the highest rates of diabetes in India. The restored water bodies will benefit citizens greatly by providing them with greater access to spaces for physical activity. More than half the restoration projects will include walkways around their periphery.

**Economic:**
The water bodies provide drainage for stormwater, protecting neighbouring properties during extreme weather events. Citizens and businesses can invest more in their property when the risk of storm-related damage is decreased, thereby boosting the local economy.

**Environmental:**
Water quality improvements in the restored water bodies have been achieved via the rerouting of sewage that once contaminated the areas. Flora and fauna can now be seen recolonising the sites, including three endemic plant species identified after restoration.

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**What can other cities learn?**

**Funnel funding into project goals:**
The project is funded publicly, as well as privately by corporations and NGOs, via the “Adopt a Water Body” concept, whereby willing contributors are assigned specific works to be carried out. Even with private funding, the framework ensures implementation is completed according to the action plan.

**Invest in the future:**
The frequency of extreme weather events in Chennai is on the rise, and each year there are millions of dollars worth of damage. While the restoration requires an estimated $15 million in investment, in only two years the city will likely see a return on investment via a reduction in damages.

**Engage a willing public:**
Devastating floods and droughts have summoned the common conscience of the public in a desire to contribute. Participation is encouraged via events that build community pride. Volunteer groups help maintain the water bodies, receiving training to check on water quality parameters and keep authorities updated.

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Many of the areas being transformed into storm buffering and drought-protecting public spaces were once dump sites. It is estimated that in the first year of the project, the public space created will be used by 1 million citizens.
**DELHI:**

Pledge provides clean and free water for all and invests in a water-secure future

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 Delhi took a political pledge to provide access to clean drinking water to all its citizens at an affordable price, and as a human right.

The comprehensive, equity-driven plan offers short-term relief by providing free lifeline water of up to 20,000 litres a month to households with metred connections, and sizeable investment in improving water security for Delhi’s residents in the future. The improvements include expansion of water distribution infrastructure, wastewater treatment, and restoring water bodies to recharge and store groundwater.

### What has the city achieved?

Delhi’s pledge of “Jal Swaraj” (Self Governance of Water) comes amidst India’s challenge of water insecurity, with many residents forced to buy water from private tankers operated by the water mafia. About 30% of Delhi’s population lives in unauthorised colonies, which are historically lacking in access to water and sanitation infrastructure.

The city is addressing this challenge via an urgent plan of action aiming to connect all residents of Delhi with water and sewage, regardless of their legal status. Citizens are offered an 80% rebate for the installation of pipelines, contributing to the goal of city-wide coverage within five years, which will provide connections to 1.4 million households currently without a piped water supply. A network of small yet efficient decentralised sewage treatment plants have been developed, primarily near unauthorised colonies, and work to treat wastewater and prevent the discharge of pollution into 281 water bodies. To address water security and recharge Delhi’s low water table, the city is promoting citizen-based water management including water conservation, recycling, and rainwater harvesting. The Yamuna River will also be restored by preventing inflow of pollutants, re-naturalisation, and the creation of dams to store floodwaters for later use.

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What has the city achieved?
What are the co-benefits?

<table>
<thead>
<tr>
<th>Social:</th>
<th>Health:</th>
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</thead>
<tbody>
<tr>
<td>The government of Delhi is making water distribution systems more transparent, efficient, and accessible by expanding infrastructure to reach communities, including those that are unauthorised. By providing equitable access to water, the city is outstaging the water mafia and creating happier neighbourhoods.</td>
<td>To beat the extreme heat, citizens will be provided with clean drinking water free of charge via hundreds of water dispensers installed in public places. Improved access to sanitation will also bolster citizens’ health, so the city has built 100,000 restrooms, mostly in unauthorised colonies.</td>
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<th>Economic:</th>
<th>Environmental:</th>
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<td>By regulating private tankers, citizens will be protected from exorbitant prices. Changes in water tariff regulations will relieve small shop owners from paying commercial water prices, aiding local businesses.</td>
<td>Delhi comprises just 2% of the catchment area of the Yamuna River, but is the source of 80% of the pollution flowing into it. An investment of $54 million has been made towards a comprehensive action plan to intercept and treat sewage.</td>
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Lake rejuvenation provides the practical benefits of rainwater collection and stormwater drainage, while the landscaped spaces around the lake offer citizens opportunities for recreation and community gathering places for religious rituals.

A photo prior to construction is pictured in the bottom left.

What can other cities learn?

Provide water for all, not just some:
Economically disadvantaged citizens are disproportionately vulnerable to water insecurity. The provision of free lifeline water, reduction of water and sewer connection charges by 80%, and reduction of pipeline development charges helps rectify inequality and systematically improve Delhi’s water security for all citizens.

Make the most out of greywater:
Delhi is working to make the most of recycled water to relieve the stress on drinking water supplies. The city has set up decentralised sewage plants in residential colonies to prevent contamination of water bodies with sewage, and provide treated water for non-drinking purposes such as toilets and gardening. Dual water systems will be rolled out across group housing societies, optimising recycled water usage.

DELHI

100K HOUSEHOLDS have received up to 20,000 litres of free water a month

100K HOUSEHOLDS
Anticipating cloudbursts of increasing intensity and frequency, Frederiksberg is taking a strategic approach to climate-proof the city. Frederiksberg announces tenders based on required criteria rather than known solutions, experimenting with a collaborative process to yield synergistic solutions. For example, the city is developing stormwater catchments that irrigate urban trees, sparing sewers during torrential rain storms, while reducing the task of manual watering. The city aims to couple all new urban trees with integrated rainwater management, where underground basins collect water that will be utilised to water trees during dry periods. Currently nine sites are planned to manage up to 1,295 cubic metres of stormwater, with ambitions to scale the project across the city.

The city also used the opportunity of construction work on a parking facility to include stormwater reservoirs beneath the building and surrounding roads, protecting the area from run-off and minimising combined sewer overflow. The project included revamping the city’s public square, Langelands Plads, to manage stormwater and protect the neighbourhood from flooding exceeding a 100 year rainfall event. The project includes a digital monitoring system enabling the active control of when and how much water is released to sewers.

Frederiksberg is testing a new type of tendering, where the city and suppliers undertake a co-creation process to create new and innovative solutions. In addition, the city is implementing an array of stormwater management programmes in synergy with construction projects and natural infrastructure, which serve as a testing ground for projects to be scaled across Denmark.

What has the city achieved?

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**What are the co-benefits?**

**Social:**
The stormwater infrastructure doubles as a public space where people can meet and children can play. Langelands Plads features a green space with a playground and facilities that encourage social activity.

**Health:**
Frederiksberg is creating stormwater infrastructure in alignment with a strategy to create more greenspaces, which provide places for recreation and help citizens cool down during summer heatwaves.

**Economic:**
Preventative stormwater management should reduce costs associated with future flooding events. In addition, Frederiksberg’s strategic approach takes advantage of opportunities to reduce expenses, such as combining projects with scheduled construction and reducing urban tree maintenance with rainwater catchments.

**Environmental:**
The stormwater infrastructure reduces the risk of combined sewer overflow during extreme rainfall events, which can contaminate the sea. In addition, flood risk is reduced in downstream regions from the projects.

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**What can other cities learn?**

**Target tech to the city’s needs:**
All too often, new technology is arbitrarily applied to projects. The digital control system at Langelands Plads is tailored to management needs rather than a technology push, and the result is a lean, replicable, and integrated system that saves the city money.

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**Collaborate across departments:**
Frederiksberg is breaking down city department silos to find new opportunities. The strategy for the coupling of torrential rain projects and urban trees is created, maintained, and funded via collaboration between several city departments.

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**New challenges require new solutions:**
The city’s willingness to engage in a co-development process between city departments and private companies leads to unique solutions. While this is an unorthodox approach, the city finds it saves time, money, and improved the quality of infrastructure solutions.

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**FREDERIKSBORG**

↑31.3K

** Cubic Metres of Water** could be managed if stormwater catchment is paired with urban trees across the city, which is planned to be integrated over the next 20 years.

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Frederiksberg’s Langelands Plads provides an attractive public space while increasing the city’s resilience. Beneath citizens’ feet is infrastructure capable of retaining 670 cubic metres of stormwater. A digital display informs curious visitors, relaying information about climate adaptation.
LISBON: Not a drop goes to waste with a recycled water programme and rain-fed greenspaces

Water scarcity events are becoming increasingly severe and prevalent in Southern Europe, with Portugal experiencing long periods of severe drought in recent years. Although Lisbon’s water reserves are not under immediate threat, the city identified an opportunity for improvement given that 75% of its water consumption is for non-potable uses, such as street washing and irrigation. Rather than sending drinking water down the drain, Lisbon has devised a strategy to optimise the use of recycled wastewater for non-potable uses, which has the added bonus of contributing less than half the greenhouse gas emissions of potable water.

Lisbon’s Strategic Plan for Water Reuse includes the creation of a city-wide recycled water distribution network and a working group to ensure public safety with regard to water quality. The plan is part of a wider Water Efficiency Strategy, anchored in a vision of a city filled with resilient green infrastructure managed with minimum water needs. Greenspaces are planted using rain-fed native species, thereby limiting the need for irrigation. Where irrigation is used, a system is deployed to rapidly detect and fix water leaks and increase efficiency. Lisbon has already increased greenspaces by more than 10% in the last decade, with a goal to reach 20% by 2021.

Lisbon is future-proofing its water supply by preserving drinking water reserves and using recycled water more widely for myriad city uses.

Lisbon’s ambitious efforts to utilise recycled water are driving policy nationally and within the EU, enabling smaller cities to follow its lead. In addition, Lisbon is greening the city without increasing overall water use, making the city more resilient to heatwaves, flooding, and reducing the urban heat island effect.

What has the city achieved?

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What are the co-benefits?

Social:
More greenspaces will improve citizens’ access to public spaces a short distance from home and work, offering them more places to meet and socialise.

Health:
Greenspaces provide citizens opportunities for exercise, improving mental health, and spaces to take shelter in during heatwaves.

Economic:
The city has proposed a new business model to introduce recycled water, creating opportunities for more affordable and sustainable water sources to be integrated in a wide variety of businesses such as car washes, heating and cooling solutions at airports, and construction sites.

Environmental:
By expanding the city’s greenspaces without increasing water demand, the city will preserve its water reserves, while allowing for the use of green infrastructure as an effective tool for adaptation to heatwaves, reducing both the urban heat island effect and the likelihood of flooding.

What can other cities learn?

Take a lead and set the standards:
Before the project, there was no existing legislation for water quality for re-use, nor a regulatory framework for the distribution and pricing of this new water product. A working group spearheaded these initiatives and comprised a broad range of public, private, and academic partners.

Invest in the future:
Previously, Lisbon had utilised recycled water via tankers; now it has implemented a more permanent and efficient solution. Including the initial $18 million investment, the city is already saving 10% on the cost of recycled water in lieu of potable water, and will see greater savings as the project scales.

Be open minded to non-traditional resources:
Public acceptance of recycled water was an initial concern in the development of the project, which was addressed by a thorough analysis and an action plan to safeguard against all potential health hazards. As severe droughts become more frequent, the municipality foresees the project will be seen positively by the community.

LISBON

30% OF THE CITY is scheduled to be covered by the recycled water network by 2025.

Lisbon is embracing greenspaces populated with native species, such as rain-fed meadows. Native species require minimal maintenance and water, while improving the city’s resilience to heatwaves and flooding, boosting biodiversity, and providing delightful public spaces for citizens to enjoy.
The One Water NYC: Water Demand Management Program has achieved savings of approximately 38 million litres of water per day since 2013, which is expected to double by 2023. The savings have been achieved via partnerships across eight NYC government agencies and 10 regional municipalities to facilitate six water-saving strategies across diverse sectors of usage. Examples of projects include the replacement of tens of thousands of inefficient fixtures; water efficiency projects implemented in parks, hospitals, and schools; and the city’s partnership with the private sector to voluntarily conserve water.

To integrate water demand management as part of the city’s ambitious climate strategy, a water-energy nexus tool was developed to calculate the relationship between decreasing water demand and reducing greenhouse gas emissions. NYC estimates that these water efficiency programmes reduce energy used for pumping and treatment by more than 570,000 kWh each year, which avoids greenhouse gas emissions totalling more than 150 tonnes CO₂e and saves NYC more than $60,000 in energy costs. By quantifying savings and linking the data to broader environmental issues, the city also promotes public awareness and behaviour change among citizens.

Despite an abundant water supply and climate change projections reporting increased rainfall, New York City has taken action to future-proof its water supply and reap the benefits of the associated energy savings.

New York City’s Water Demand Management Program will ensure the city increases its climate resiliency, while hosting an ever-growing population. The plan works to reduce water demand and costs, cut carbon and nitrous oxide emissions, and prevent combined sewer overflows.
What are the co-benefits?

Social:
Citizens benefit from free retrofits under the programme. For example, the Toilet Replacement Program offers citizens high-efficiency toilets at no charge, and will further save them money on their monthly utility bills.

Health:
Demand management also reduces flow to sewers and therefore the risk of combined sewer overflows, which can contaminate local waterways during periods of high rainfall. By preventing sewer overflows, citizens can enjoy local rivers and waterside parks without fear of illness.

Economic:
The city estimates that each year more than $60,000 in energy costs for treatment of potable water and wastewater will be saved as a result of the programme. By reducing water demand and wastewater flows, it is estimated that each year the programme avoids more than 150 tonnes and 77 kg of CO₂e and NOx emissions, respectively.

Environmental:
NYC’s Toilet Replacement Program engages members of the community, specifically multi-family residential building managers and owners, to retrofit fixtures. As part of the programme, NYC establishes contracts with local private plumbing vendors, and participants redeem their vouchers with the vendors to receive free, high-efficiency toilets.

What can other cities learn?

Collaborate to amplify impact:
The funding body, New York City’s Department of Environmental Protection, has direct ownership of a small percentage of the facilities targeted for savings. Therefore, citizen engagement and collaboration between other agencies and private building owners and managers has been key to the project’s success.

Show off your wins:
By sharing information with the public, they can get behind the positive changes implemented by their local government. NYC created an interactive online map where the public can view the implemented projects and the associated water, energy, and greenhouse gas emissions savings for each drainage area.

Let challenges inform best practices:
“Water Challenges” were launched with hotels, restaurants, hospitals, and universities, where participants calculated baseline water consumption, tracked usage, and developed conservation plans. The results informed the creation of water efficiency guides for these respective sectors and identified sector specific saving opportunities.

NEW YORK CITY

38 MILLION
LITRES OF WATER saved per day since 2013
Facing up to the major challenge of urban flooding, the Chinese national government is promoting the Sponge City concept to help cities soak up rainwater and improve their resilience to climate change.¹ Zhenjiang has embraced the approach, requiring under city policy that every new project started after October 2015 must conform to the Sponge City requirements. The municipality established a management method and office to promote Sponge City development in order to secure resources for future projects. The city has deployed a pilot project of approximately 19 km² focusing on one lake and three rivers. The project sets a strategy to intercept wastewater discharge, purify rainwater, and protect the health of waterways. An analysis was conducted to measure the sources of various pollutants, develop a plan for how they can be reduced, and calculate how much wastewater can be discharged according to the Total Maximum Daily Load. Via strategies, including separating wastewater and stormwater infrastructure and ensuring wastewater is treated before it is discharged, the Sponge City project will protect local water bodies such as the Yangtze River from contamination.

With the Yangtze River to the north, mountains to the south, and smaller rivers interlacing its boundaries, the City of Zhenjiang is at a high risk of flooding. To address this challenge, the city is soaking up rainfall via its Sponge City project, designed to retain and release rainwater while reducing pollutants.

ZHENJIANG: 
Sponge city soaks up rainfall to boost climate resiliency

What has the city achieved?

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What are the co-benefits?

Social:
Greener and cleaner cities have improved public spaces, offering new opportunities for recreation, leisure, and meeting places.

Health:
Improving drainage and water quality is eliminating stagnant, foul-smelling, and polluting waterways, which could lead to reduced risk of waterborne diseases and improved quality of life.

Economic:
Improving Zhenjiang’s resilience to flooding and extreme weather events provides a more secure environment for businesses and residents to invest. The public-private partnership between the city and Sponge City industry partners will boost the local economy and create jobs.

Environmental:
Reducing pollutants in the local waterways improved the opportunity for biodiversity to flourish. Greener cities also reduce the urban heat island effect, helping provide a cooling microclimate during heatwaves.

What can other cities learn?

Sponge-ify your city:
The Sponge City concept is being widely adopted across Chinese cities, and for good reason. Urbanisation reduces permeable surfaces, further exaggerating flooding risk. Resilience is improved when cities are developed with rainwater infiltration in mind. Permeable pavement and naturalised spaces work to not only absorb water but also recharge groundwater and provide opportunities for grey water to be re-used during the dry season. ¹

Leverage Public-Private Partnerships:
The city has raised around $200 million via public-private partnerships, which the city will engage in over the 23 year lifespan of the project. The project has a capital fund of approximately $62 million, with the government owning 30% of the equity share and the private partners owning 70%. The companies involved in Sponge City not only serve the projects in Zhenjiang but 10 others across China.

ZHENJIANG

2025

IS THE YEAR by which Zhenjiang aims to have their urban areas entirely compliant to Sponge City standards

While the unknowing pedestrian could pass it by without a second glance, modest yet effective green infrastructure provides a plethora of benefits including absorbing and rerouting stormwater, improving the water quality of runoff, recharging groundwater, while also improving public space, and fostering urban biodiversity. ¹

The Cities100 report features 100 leading climate action projects from cities around the world. The report demonstrates that cities’ leadership on the climate crisis provides the added benefit of creating safe, liveable, and equitable cities for all citizens.

The 2019 digital report is the fourth edition of Cities100 and features 12 different categories of climate action.

Cities100 is a collaboration between C40 Cities and Nordic Sustainability, and is funded by the Danish philanthropic association Realdania.

Read them all by visiting: cities100report.com