Thought Leadership

Running dry

Enhancing the resilience of APAC cities to water stress

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Executive Summary

Cities are on the front line of climate change, which is intensifying an often under-appreciated but potentially existential threat to many cities—water scarcity. This report outlines a series of new and emerging technologies that can reduce urban water stress and provides a framework to arm cities with the tools to determine the most locally impactful solutions.

Urban water scarcity already has a large impact: Today over 12% of GDP is generated by large cities already facing high water scarcity. Moreover, this impact is set to grow, as currently water-rich large cities responsible for some 4% of GDP could move into stressed territory by 2050 under a high emission, high development scenario.

APAC exposure to urban water stress

Asia is particularly exposed to this issue. It contains 60% of the world's population but only 28% of the world's freshwater reserves. APAC contains many of the world's largest cities by population, which already collectively face some of the highest water stress—the ratio of reliable water supply to demand. Rapid urbanization, population growth and rising living standards are likely to exacerbate these issues in APAC in the coming years.

What can be done?

While the above paints a gloomy picture, cities often demonstrate a remarkable ability to resist the threat of water scarcity, from the development of sewerage and hydraulic infrastructure to market policies like water pricing. Further efficiency gains are possible. In this report we outline a series of new and emerging technologies that can reduce a city's vulnerability to water stress.

The next stage in urban water evolution

The evolution of urban water management can arguably be traced back several thousand years, from the first bore wells dug in the Yellow River area, to the first signs of sewerage systems in the Aegean Islands through to the first water treatment plants in Scotland in the 19th century. Today, urban water management is in another major evolutionary phase. Sensor roll-out, Internet of Things technology, automation, circular water system management and an integrated approach which looks at the water supply chain as a system rather than a sum of disparate parts, all raises the potential for reductions in usage, waste and pollution, and gains in efficiency and, ultimately, sustainability. For example, the use of sensors and Internet of Things technology in Malang City, Indonesia helped to reduce its water loss rate from 42% to 15.9% in ten years.

What governments and finance can do

Governments enjoy an outsized influence over urban water management because water utilities are often wholly or partly state-owned. Even where they are not, they set the rules in what is a heavily regulated sector. Infrastructure investment in APAC is typically government-led, but upgrading urban water infrastructure will also require significant input from private investors. The global cost of meeting Sustainable Development Goal (SDG) 6 (clean water and sanitation for all) could be USD 1.04tr (in 2015 US dollars) or 1.2% of global GDP through to 2030, with East Asia and Pacific accounting for USD 250bn per annum and South Asia for USD 150bn. Overall, that is three times the current level of investment. Global private investment in water infrastructure stood at a meagre USD 17bn out of just over USD 1tr of private infrastructure investment in 2020. The private sector can and should do better.

Where to start

Not all the solutions outlined in this report will suit every city. For example, some cities in countries at earlier stages in their development may need to prioritize basic sanitation over the latest technologies. Most cities will build up water resilience over time by prioritizing the most locally impactful solutions. We include two useful tools to help provide a framework for determining these: local stakeholder maps, and solution feasibility assessments. These tools send two important messages: First, the 'right' stakeholder relationships are critical. For instance, well-resourced utilities are possibly the only actors who can roll out infrastructural solutions like network sensors. Cities without well-resourced utilities may struggle to implement such solutions. Second, smart water meters, rainwater harvesting, and efficiency labelling and standards are arguably 'low hanging fruits' that generate significant impact with low barriers to implementation.

1. Cities under pressure

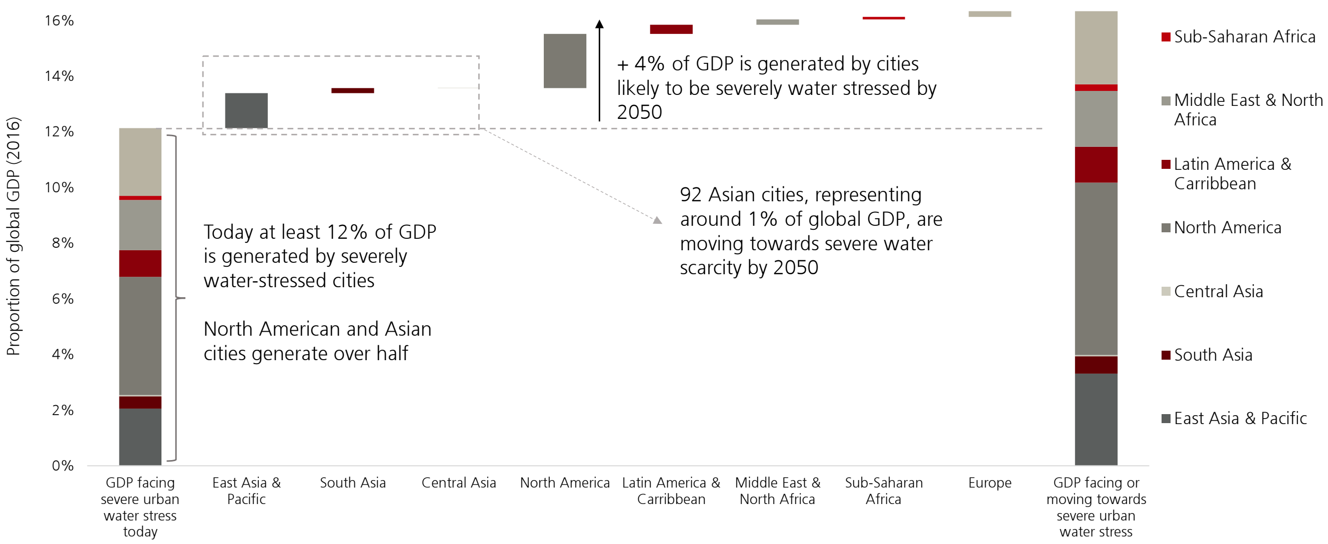
As cities expand, they encounter pressing challenges that demand strategic attention. Strained transport networks demand new mobility solutions; densification gradually squeezes out green space.

Perhaps most of all they find themselves on the front line of climate change. They contribute disproportionately—housing just over half of the world's population but generating 70% of CO_2 emissions[1]—and they experience some of the worst consequences, such as more frequent and intense heatwaves worsened by urban heat island effects.

Furthermore, climate change is intensifying an often under-appreciated but potentially existential threat to many cities—water scarcity. Today over 12% of GDP is generated by cities already facing high water scarcity (Figure 1). And the problem is growing, with currently water-rich cities responsible for some 4% of GDP at risk of moving into stressed territory by 2050.

Figure 1: Over 12% of global Gross Domestic Product is exposed to urban water stress2

Water-stressed large cities (>300,000) account for 12% of global GDP. By 2050 it's likely that more cities will experience water scarcity, which could expose a further 4% of today's GDP under a high development and emissions scenario.



Source: UBS; He, C et al (2021), Future global urban water scarcity and potential solutions; World Bank (2022), World Bank National Accounts and OECD National Accounts data files.

[1] Dasgupta, S et al (2022), Cutting global carbon emissions: Where do cities stand?, World Bank.

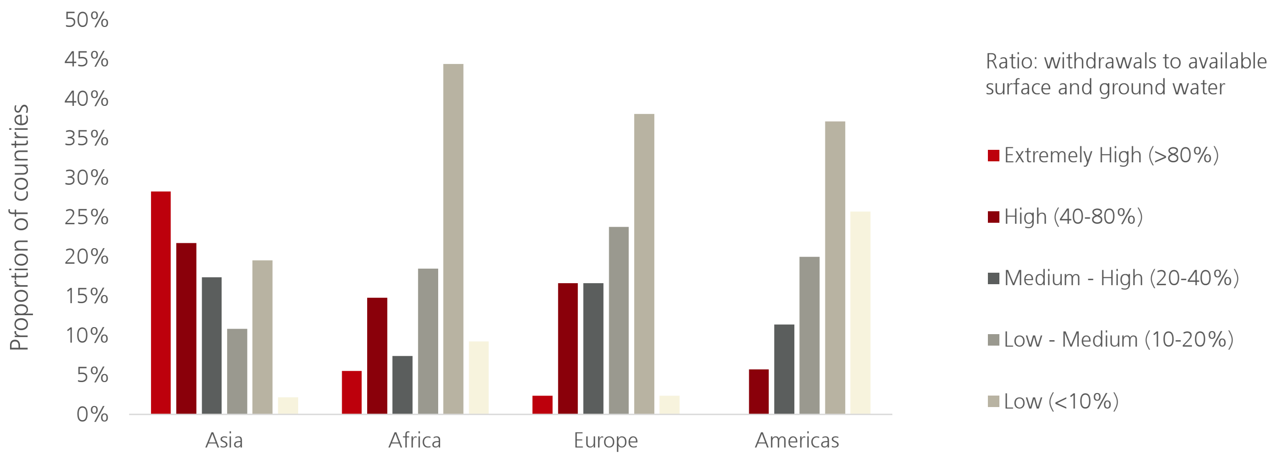
[2] UBS; Urban GDP estimates from World Bank (2022) (national GDP per capita multiplied by city population); Urban water stress scenarios from He, C et al (2021) (scenario SSP5 & RCP8.5); While this is based on a high emissions scenario, the projection could be underestimated for two reasons: 1) 'Urban GDP' as a share of national GDP will grow as urbanization accelerates (this analysis uses 2016 GDP and population figures); and 2) Urban residents are more productive than rural (this analysis distributes GDP on a per capita basis).

1.1. Urban water stress in Asia Pacific

This report focuses on the dangers and solutions related to urban water scarcity across Asia Pacific (APAC). Asia contains 60% of the world's population but holds only 28% of the world's freshwater reserves,[3] making it particularly vulnerable to water stress. The region contains several of the world's largest cities, and collectively they face higher water stress—the ratio of reliable water supply to demand—than anywhere else (Figure 2). These risks are likely to deepen as climate change progresses and the trend towards urbanization accelerates, potentially leaving some of these cities dangerously short of water during the driest times of year.

Figure 2: Half of Asia's countries experience high water stress, far higher than other regions

Almost a third of Asian countries experience extremely high water stress, while 22% face high water stress



Source: UBS; World Resources Institute (2019), *Aqueduct 3.0 Country Rankings.*

Urban water stress broadly takes place at two levels, and both are set to worsen in APAC cities over the coming decades:

1. **At city level**
   The world's population continues to grow, and urbanization is bringing more people to cities, intensifying water demand. Across Asian subregions the proportion of people living in urban areas today ranges between 37-72%, but forecasts imply this range will shift to 54–81% by 2050.[4] Exacerbating the issue, urban residents also tend to consume more water than their rural counterparts.[5]

2. **Beyond the city level**
   Cities face increasing competition for water resources, particularly given rising industrial and agricultural demand (Figure 3). On current trends, global demand for freshwater could outstrip supply by 40% by 2030 (Figure 4).

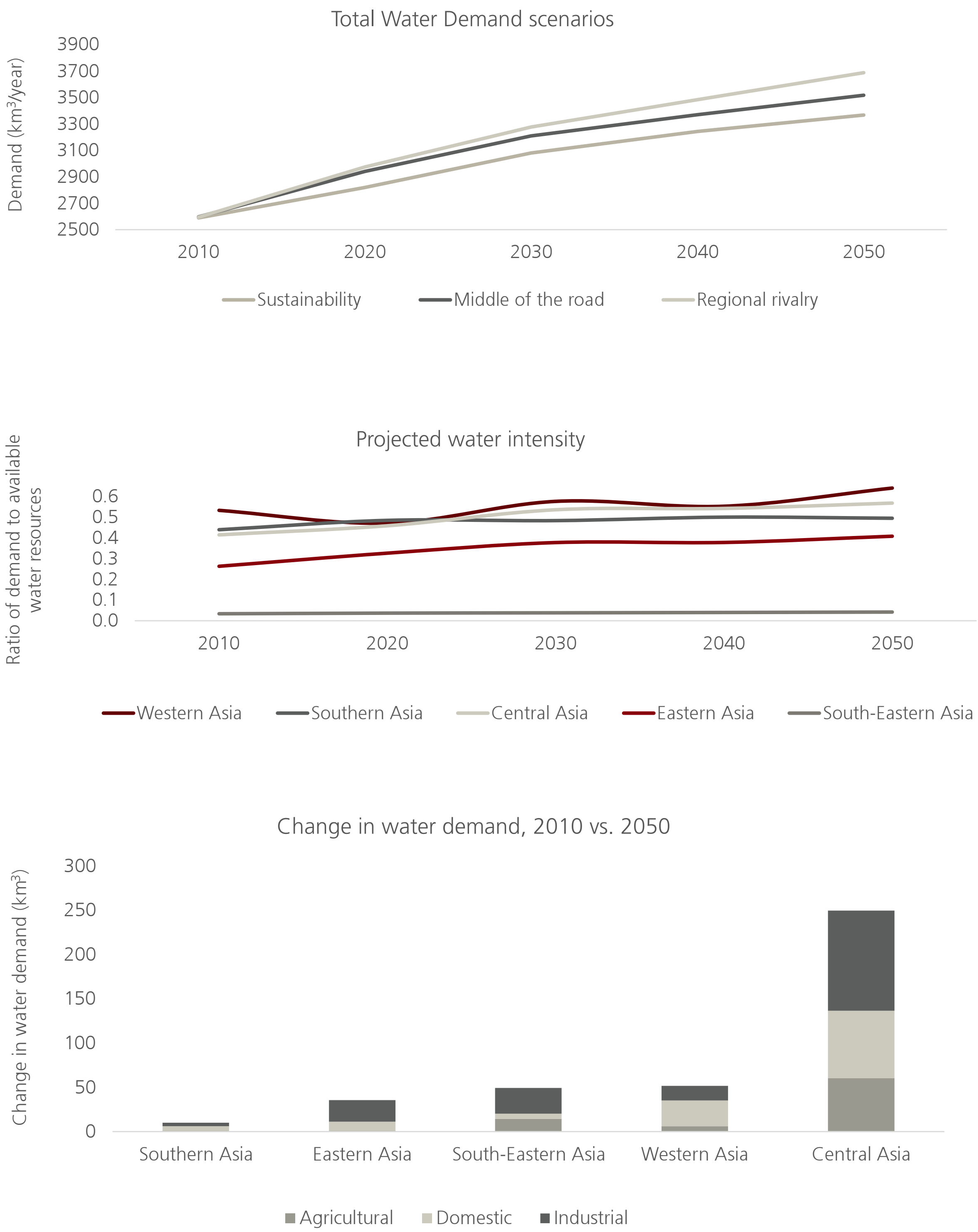
[3] UN Food and Agriculture Organisation, World Water Resources by Country

[4] Ritchie, H. and Roser, M. (2019), Urbanization across the world today, Our World in Data.

[5] Paterson, W. et al (2015), Water Footprint of Cities: A Review and Suggestions for Future Research, Sustainability 2015, 7(7), 8461-8490.

Figure 3: Water demand forecast to rise across Asia Pacific, increasing competition for supplies

Aggregate demand for water across Asia could increase by 26% from today's levels by 2050, mostly driven by increases in domestic and industrial demand.[6]

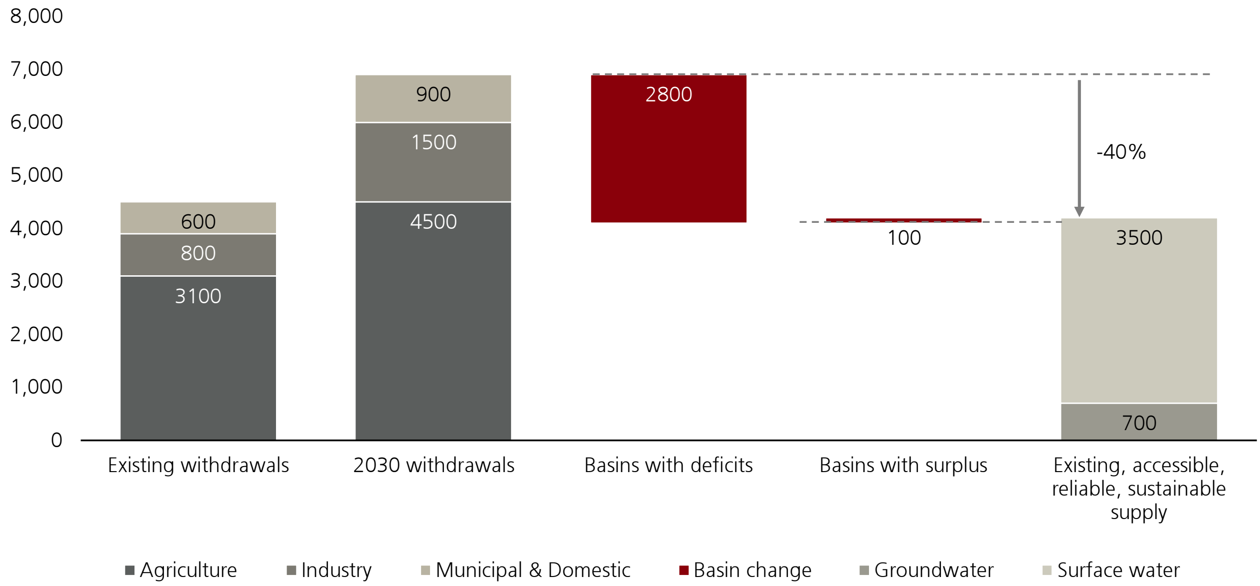


Source: UBS; International Institute for Applied Systems Analysis (2020), *WFaS Fast-Track Initiative.*

[6] Water demand figure based on the central 'Middle of the Road' scenario, change in demand from 2010 to 2050, from IIASA (2020), WFaS Fast-Track Initiative.

Figure 4: Global water demand could outstrip usable supply by 40% by 2030

Forecast of water demand (2010) and future usable supply (2030), assuming no productivity gains.



Source: UBS; McKinsey (2009), Charting Our Water Future: Economic Frameworks to Inform Decision Making.

These trends paint a gloomy picture, but cities across the world have proven to be surprisingly resilient. They have often demonstrated a remarkable ability to resist the threat of water scarcity, from the development of sewerage and hydraulic infrastructure to market policies like water pricing. Further efficiency gains are also possible, as shown by recent scenarios that suggest regions with better water management could ease the risks and even enhance their economic growth.[7]

In this report we outline a series of new and emerging technologies that can reduce a city's vulnerability to water stress. We assess each option while weighing their stakeholder, financing and in some cases geographic constraints. By implementing a combination of these solutions, many of APAC's leading cities should be able to reduce their vulnerability to water scarcity.

[7] Kuzma, S. et al (2020), Achieving Abundance: Understanding the cost of a Sustainable Water Future, World Resources Institute.

2. What are the solutions?

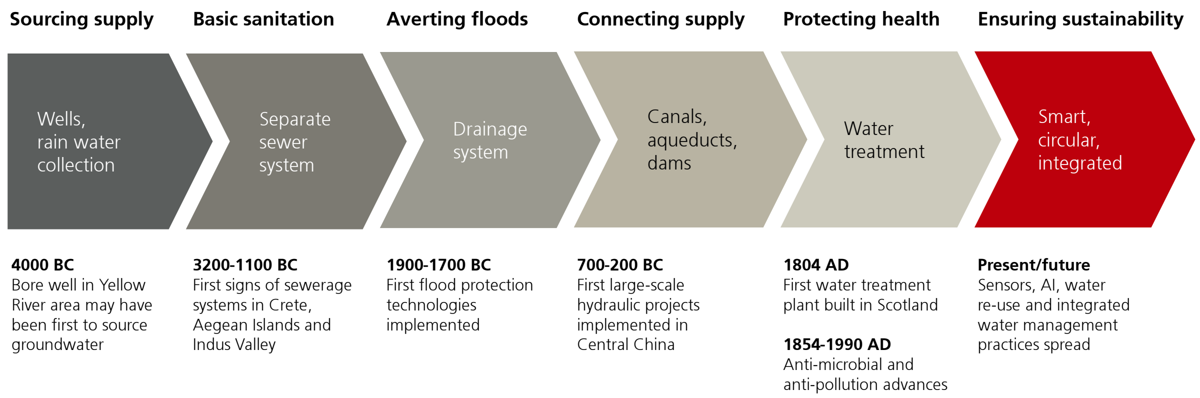
For thousands of years humanity has strived to improve the management of water in major settlements (Figure 5). Early innovations sought to connect settlements to water supplies; over the centuries this has evolved to a modern focus on minimizing water usage, maximizing efficiency and encouraging reuse. Today, with more people alive than ever before, some traditional sources of water supply are coming under increased strain. To cope, urban water management has entered a new evolutionary phase.

Box 1: Integrated Urban Water Management

Integrated Urban Water Management (IUWM) refers to a set of principles for holistically managing water. It links the water supply chain—from use and reuse to ecosystem impact—with an institutional, social and policy framework. In practice, this means appraising options on a total community cost basis, sustainable sourcing, minimizing usage, leakage and waste, optimizing efficiency and re-use, and aligning city drainage with ecosystem needs.

Figure 5: The Evolution of Urban Water Management

Urban water management has progressed over thousands of years, moving from a focus on securing basic supply to ensuring that supply is clean, reliable, and efficient



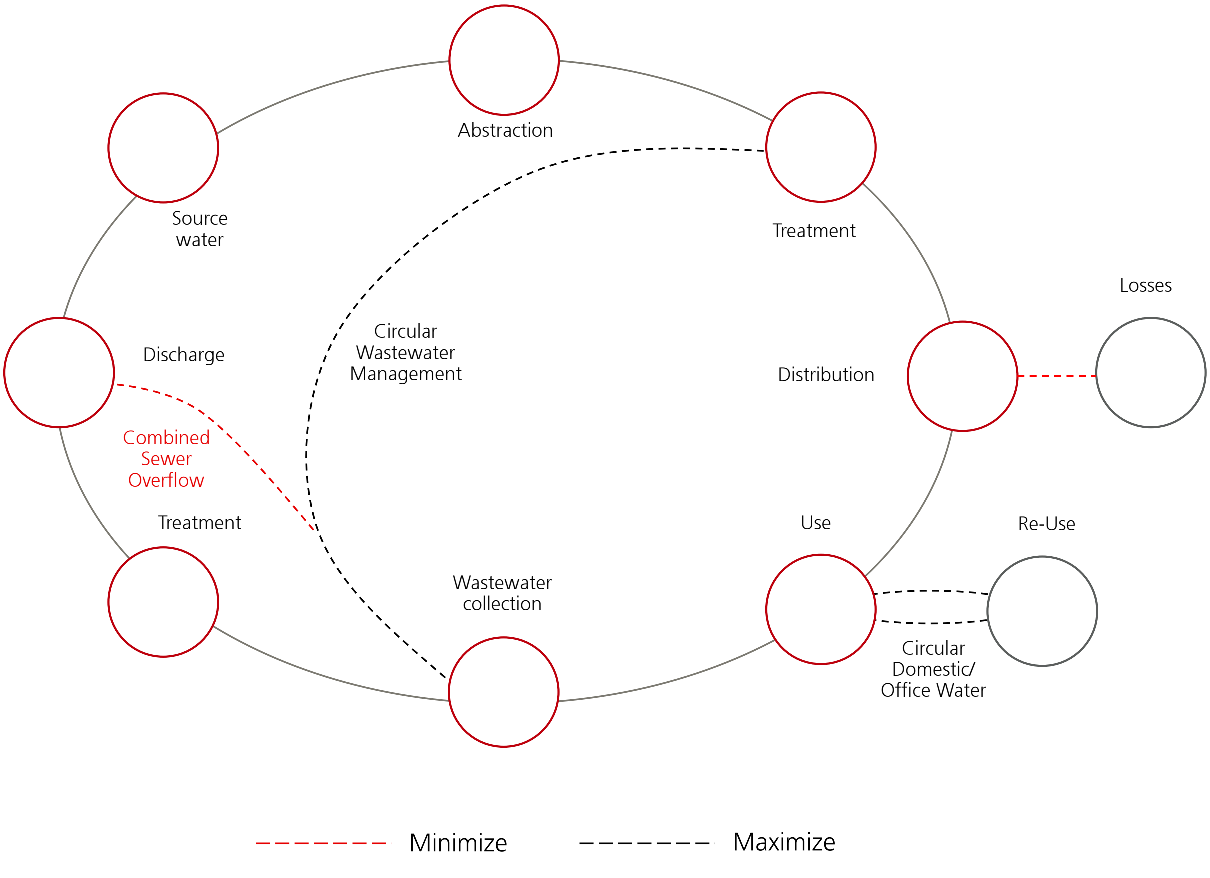
Source: UBS; Joseph, K. et al. (2022), Development of an Intelligent Urban Water Network System, MDPI; Enzler, S. (2019), History of Water Treatment.

2.1. The next stage of urban water management is smart, circular and integrated

To ensure the sustainability of their urban water supply, APAC cities need to do two things: First, they should wherever feasible seek to introduce the next technical advancements in urban water management—smart water and circular water. These have been covered in other UBS reports,[8] so for the sake of brevity we will go into limited detail in this report; Second, they need to tailor these upgrades into a strategy based on Integrated Urban Water Management principles (Box 1) in order to optimize their water supply chain, visualized in Figure 6.

Figure 6: Optimizing the water supply chain

High level view of how water flows through cities, with key targets for optimization in dotted lines.



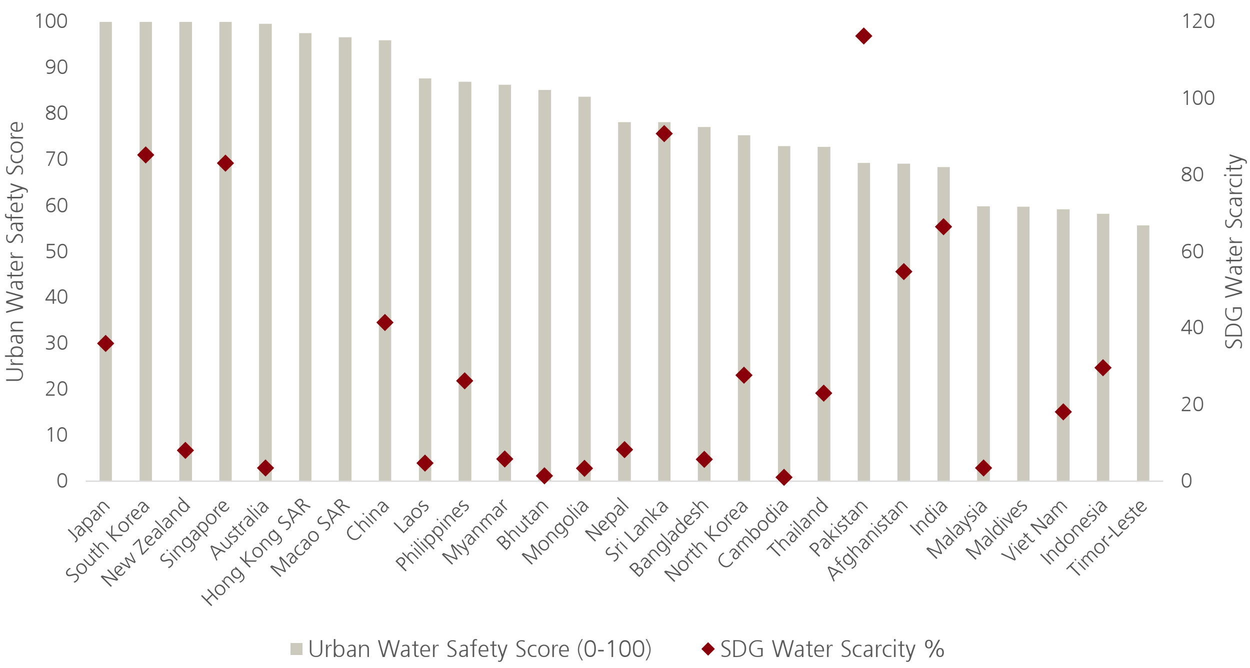
Source: UBS.

[8] UBS Chief Investment Office (2023), Water Scarcity Update

Not all the solutions in the following pages will suit every city, for financial, developmental, or geographic reasons. For example, some cities in countries at earlier stages in their development may need to prioritize basic sanitation over the latest tech solutions (Figure 7). But each of them can, if deployed appropriately, strengthen the overall urban water supply chain and system (visualized in Figure 6).

Figure 7: APAC countries have varying levels of preparedness for and exposure to urban water scarcity

Those with high water scarcity but low urban water safety may look to focus more on providing basic water services, such as clean water and access.



Source: UBS; World Health Organization and UNICEF (2023), Joint Monitoring Program; Food and Agricultural Organization (2023), Aquastat core database.

2.2. The technology and techniques driving the next stages in urban water management

Smart water and smart water meters

Smart water essentially refers to the use of sensors in the system (i.e., pipe and sewerage network) to collect data about water demand, quality and supply. The combination of sensors with Internet of Things technology can help increase the sustainability of the overall system by enabling more efficient leak and blockage detection and remedy, reducing the amount of Non-Revenue Water (water lost to leaks or illegal connections), which typically comprise around 30% of daily supply and can rise up to 65%.[9]

[9] Asian Development Bank (2007), Curbing Asia's Nonrevenue Water.

Case Study: Malang City, Indonesia

Malang City introduced a water loss control program in 2009, using sensors and Internet of Things technology to facilitate Active Leakage Control. This helped reduce its water loss rate from 42% in 2009 to 15.9% in 2019, with the rate falling to 20% in the first four years.[10]

Smart water meters are installed at the household level, increasing the accuracy of metering while also better informing customers of their consumption. A 2021 study revealed that the installation of smart water meters led households to voluntarily reduce their water consumption by 2% on average.[11]

Case study: Seosan, South Korea[12]

A drought and high leakage rates led the Seosan municipal authority to install a smart water metering system. The 'revenue water ratio' (i.e., water that is properly paid for) increased by 20%. Today the global market for smart water meters is roughly USD 7bn.

Real-time adjustments

The introduction of sensors not only improves leak detection; it also opens the door for AI to optimize system management in real-time. For example, the combination of software with robotic sampling tech can automate sampling and response measures, helping to optimize wastewater treatment. It can also enable dynamic system pressure management. Reducing system pressure reduces the pressure on pipes, resulting in fewer failures and leaks, and therefore less water loss. A 2017 study found that leakages could be reduced by up to 37% through the adjustment of water pressure.[13] Pressure reduction also requires significantly less energy to pump water round the system, which helps to reduce emissions.

Case study: Cape Town, South Africa

Cape Town reduced its water pressure as part of a broader response to a one-in-400-year drought that occurred between 2015 and 2018. The use of pressure management zones covering two thirds of the water network enabled savings of 70 million liters per day during the drought's height in 2018.

Circular water

Typically, 80% of wastewater is not treated or reused (UBS March CIO Water Scarcity update), introducing circular systems therefore represents a major potential sustainability upgrade in water

[10] Romdloni, A. (2020), Control of Water Loss in the Drinking Water Distribution System of Malang City PDAM, International Journal of Science and Research; Tien, M. and Magdalena Setiono, I. (undated), Digitalisation and innovative financing – 3 steps to the sustainable reduction of non-revenue water in Indonesia, Infrastructure Asia.

[11] Daminato, C. et al (2021), The impact of smart meters on residential water consumption: Evidence from a natural experiment in the Canary Islands, Resource and Energy Economics.

[12] EBRD Green Cities (undated), Smart Water Management: Seosan, Korea.

[13] Samir, N. et al (2017), Pressure control for minimizing leakage in water distribution systems, Alexandria Engineering Journal.

scarce systems. This can happen at the system level, whereby wastewater is treated and reused for non-potable uses or heavily retreated to the point it can be added to drinking water supplies, as pioneered by Singapore's NEWater system. It can also take place at the building level - systems can be installed to collect non-potable water such as waste- or rainwater and make it usable for non-drinking purposes like toilet flushing or car-washing. All-told, about 65% of domestic wastewater is greywater which could be reused in this way.[14]

Case study: San Francisco, United States

San Francisco has imposed regulations to ensure all large new buildings have greywater recycling. It also deploys strategic grants for important projects: the city financially supported the Sales Force Tower's 'black water recycling' system, which is expected to save 7.8 million gallons a year. The city's public water commission also offers rebates on retail greywater recycling equipment, lowering costs for households (e.g., the 'Laundry-to-Landscape' scheme).

A systems approach in practice

The best way to optimize urban water management is to combine smart, circular solutions with an approach that aligns water supply, drainage, use and policy (e.g., regulatory). For example, 'Sponge Cities' aim to increase a city's ability to absorb water by replacing impermeable surfaces with permeable ones, boosting supply, and reducing flood risk. For example, stormwater can be harvested via permeable pavements. Alternatively, nature-based solutions, such as bio-retention cells (i.e., green areas landscaped to lie low and collect run-off), green roofs and vertical gardens can reduce water run-off and flood risk as well improving water supply by natural filtration. They also offer other benefits, such as increasing local biodiversity, boosting food production, and reducing urban temperatures.

Case study: Suzhou, China

Suzhou employs a mixture of bio-retention cells and permeable pavements to absorb stormwater run-off. A study[15] found that approach captured 91% of runoff, reduce flooding risk and reduced the amount of suspended solids in the water supply by 56%.

Increased modularity of systems

Where possible, cities should strive to have multiple resource, treatment, storage, and distribution options. This enables the water system to be divided into smaller blocks, which can ensure that services continue to be provided even when there are isolated system failures.

Reservoir upgrades

Water losses from reservoir evaporation are significant, at 20% of global water consumption, and they grew by 5.4% per decade between 1985-2018.[16] Efforts to reduce them are therefore potentially very

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[14] College of Agriculture, Consumer and Environmental Sciences New Mexico State University (1990), Safe use of household greywater.
[15] Zhang, Y. et al. (2020), Assessment on the Effectiveness of Urban Stormwater Management, MDPI
[16] Gang, Z et al (2022), Evaporative water loss of 1.42 million global lakes, Nature

valuable to system sustainability. This is done by reducing the surface area of water exposed, either by deepening the reservoir, or by using an aquacap to cover it. Recent years have seen the growth of 'floatovoltaics', whereby solar farms are floated in reservoirs, simultaneously cooling the panels, thereby increasing their efficiency, while reducing evaporation over the area covered by a claimed 90%.[17]

Water efficiency labelling and minimum standards

Shower, toilet, kitchen, and laundry appliances account for around 77% of household water use.[18] A UK-focused study[19] found that a mandatory water efficiency labelling scheme (similar to existing energy efficiency labels) could reduce per capita water consumption by up to 13 liters per day after 25 years, which could rise to 31.4 liters if combined with improved building regulations and minimum standards.

Desalination

Desalination is not the 'first resort' in sustainability terms due to its energy intensity, but it is crucial to supporting urban water resources in some areas, the most obvious being Singapore. The market is expected to grow by 9% a year from 2022 to 2030, reaching a total value of USD16 billion, with growth expected to be fastest in the APAC region.[20]

Energy requirements for reverse osmosis, which accounts for 80% of desalination capacity, have fallen from 15-20 kWh per cubic meter in the 1970s to 3.5-4.5 kWh today,[21] but unfortunately, physical constraints mean that is unlikely to fall much below 1.9kWh. Over the longer term, new processes will be needed to make further energy gains. There are several potential candidates, including capacitive deionization and solvent-based extraction.

Case study: Adelaide, Australia

Adelaide built a large reverse osmosis desalination plant in 2011 that can supply 100 gigalitres of water per year, equivalent to half metropolitan Adelaide's water needs. The plant was built within its budgeted AUD 1.83billion and produces water at 3.47-3.7 kWh per cubic meter.

[17] News article, (2014) Floating solar power plant would reduce evaporation, proponent says, ABC News
[18] Public Utilities Board (2020), Make Every Drop Count: Continuing Singapore's Water Success.
[19] Energy Saving Trust (2019), Water Labelling Review Summary Report, P7.
[20] Polaris Market Research (2022), Water Desalination Equipment Market Share.
[21] Goergen, R. (2022) The future of desalination, Geographical.

3. Making it happen

From Adelaide to Shenzhen, the water needs of APAC cities are very diverse. Some face severe water stress, while others have bigger issues around stormwater. Similarly, desalination is only a useful solution for water-starved cities that are based near the coast.

However, while there is no universal blueprint for solving urban water scarcity, cities face enough broadly similar issues that it is possible to introduce clear institutional frameworks and capital structures to help implement and scale solutions.

3.1. The Role of Government

Governments enjoy an outsized influence over water and sewerage utilities, given that they are often wholly or partly state-owned. Even in privatized systems, governments set the rules of the road in what is a heavily regulated sector (Table 1). As a result, they have a critical role to play in introducing new technologies and systems.

Table 1: Governments have various levers at their disposal

From blunt regulatory instruments to lighter-touch interventions like education, governments can address water scarcity using a combination of complementary tools.

Role	Description
Targets	Setting targets, such as water efficiency per head, can send signals about the direction of policy, helping create a more certain environment for investment.
Regulation	Regulations offer a blunt instrument to accelerate progress. For instance, water efficiency standards can generate faster water efficiency gains than voluntary labelling standards.
Permit trading	Water permit trading is less advanced than its emissions counterpart but has been shown to work in Australia. Technology may also allow for greater creativity: a study[22] last year suggested smart water meters could underpin a WeChat-based trading platform whereby households sell permits to industry.
Financing	Public authorities play a major role in whole-financing or part-financing infrastructure projects and decentralized solutions (such as smart meters) to attract private capital, particularly where investment risks are deemed high.
Institutional framework	Integrated water management requires coordination under a clear, holistic governance framework. For instance, Melbourne introduced the Office of Living Victoria following a drought to help catalyze integrated urban water management by providing the institutional framework for inter-agency collaboration.
Education	Reducing demand partly hinges on changing behavior. Governments play a significant via information campaigns in helping consumers and corporates become "water-wise."

Source: UBS

[22] IWA (2016), The Journey to Water-wise Cities

3.2. The Role of Finance

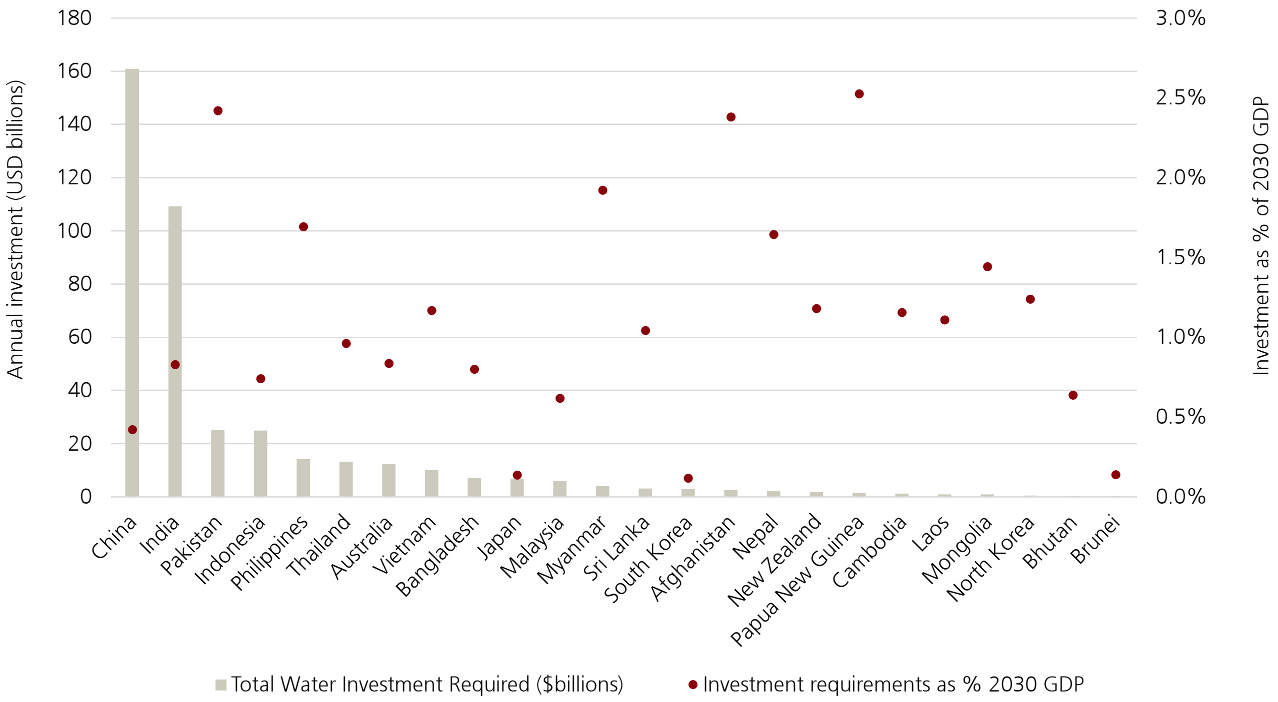
Achieving water sustainability requires significant investment. The cost of the world meeting Sustainable Development Goal (SDG) 6 (clean water and sanitation for all) could be USD 1.04 trillion (in 2015 US dollars) or 1.2% of global GDP every year through to 2030. That is three times the current level of investment.[23]

East Asia and the Pacific account for the largest share of that estimate, at over USD 250 billion per annum, with South Asia having the third largest requirement, at USD 150 billion per annum.

Within APAC, China and India account for the largest absolute investment requirements, followed by Pakistan, Indonesia and the Philippines (Figure 8). In percentage output terms, Pakistan, the Philippines and Vietnam all need to spend over 1.5% of GDP annually to be on course to achieve SDG6.

Figure 8: Asian water investment needs are dominated by China and India

While the total investment needed to meet water-related Sustainable Development Goals (SDGs) is highest in larger APAC economies, a few players face investment burdens pushing 2.5% of their 2030 GDP.



Source: World Resources Institute (2020), Achieving abundance: Understanding the cost of a sustainable water future.

Where will this investment come from? APAC infrastructure investment has typically been government-led.[24] But upgrading urban water infrastructure also requires significant input from private investors. Global private investment in water infrastructure stood at meagre levels as of 2020, accounting for just USD 17 billion of just over USD 1 trillion of private infrastructure investment.[25]

[23] WRI, (2020) Achieving abundance: Understanding the cost of a sustainable water future.

[24] Leckie, H. et al, (2021) Financing water security for sustainable growth in Asia and the Pacific, P26.

[25] OECD (2020), Green Infrastructure in the Decade for Delivery.

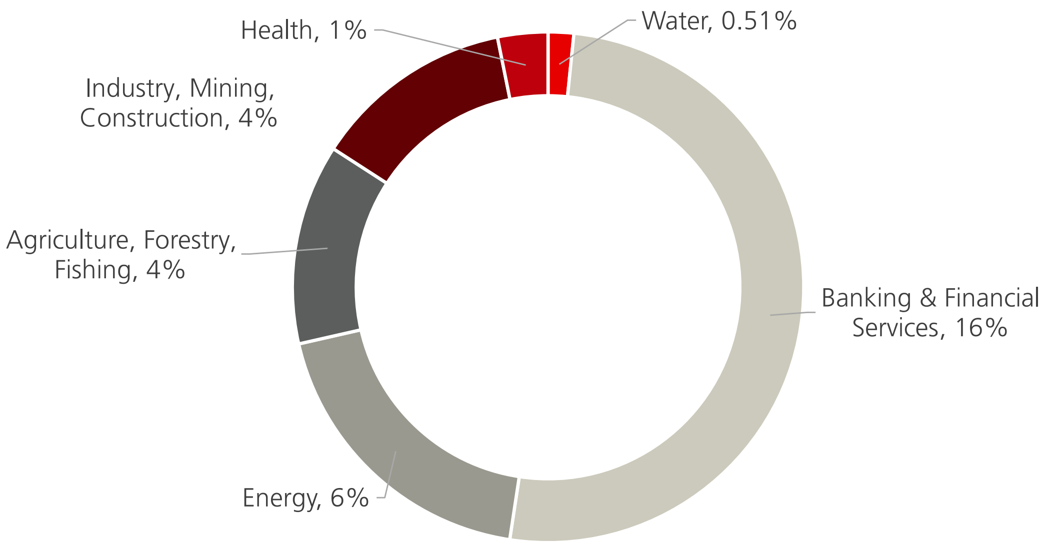
World Bank data show that private sector participation in low- and middle-income water and sewerage infrastructure projects in East Asia and Pacific peaked in 2020, the year of COVID, and had yet to recover as of the first half of 2022.[26] The private sector looks to be under-serving the financing needs of APAC water infrastructure.

The high capital requirements and long repayment periods (anecdotally 20-30 years[27]) for water infrastructure can make it difficult to attract private capital. But there are potential solutions:

1. **Blended finance,** i.e., public capital taking up-front risk to encourage private sector participation. Water investment currently accounts for a tiny portion of blended finance flows, just 0.5% from 2016-2018 according to the OECD (Figure 9).

Figure 9: The water sector represents a thin slice of global blended finance[28]

Only 0.5% of blended finance mobilized by official development finance institutions from 2016–18 flowed to water.



Source: OECD (2022), Financing a Water Secure Future, Chapter 4: Mobilizing additional sources of funding and finance.

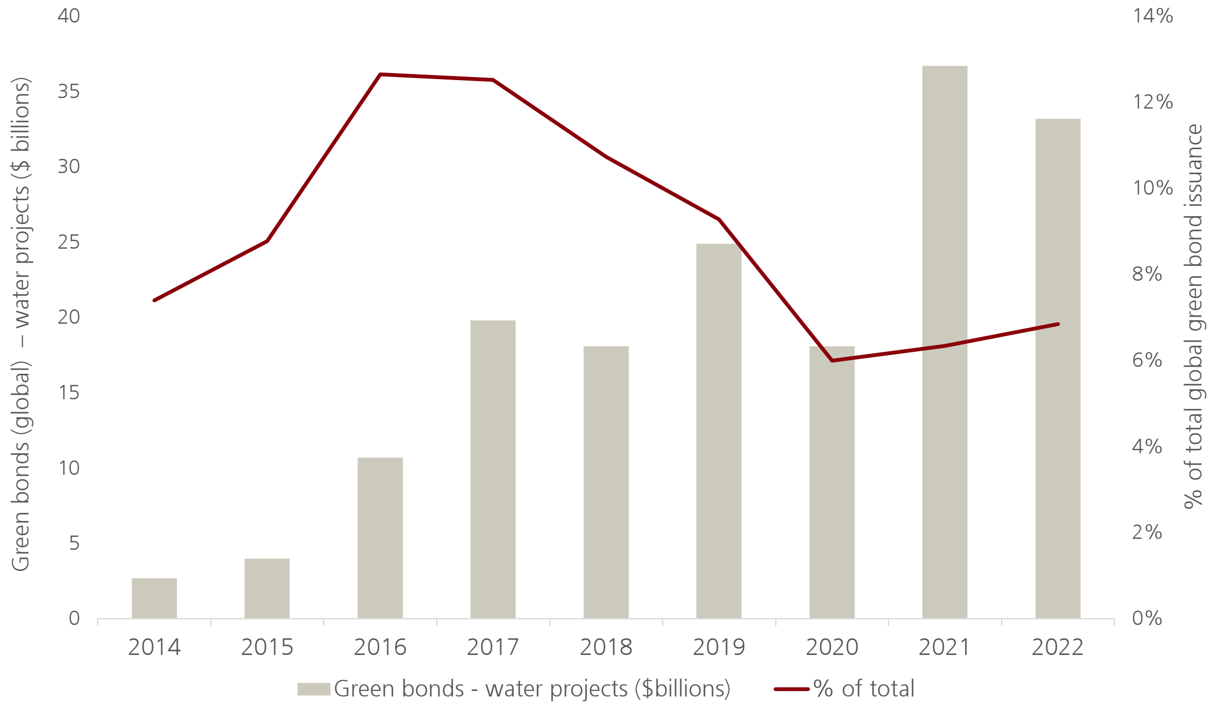
2. **Revolving funds,** which continuously recycle proceeds into further projects. The Philippines Water Revolving Fund Support Program mobilized USD 234 million of loans for water supply and sanitation projects, 60% of which came from the private sector.[29]
3. **Public-Private Partnerships (PPP)** allow governments to fund public infrastructure off-balance sheet by using private capital. Water supply and sanitation PPPs typically use a 'Build-Operate-Transfer' model,[30] meaning a private entity funds and operates the infrastructure before transferring the asset to public ownership.

[26] World Bank (2022), Private Participation in Infrastructure database.
[27] OECD (2018) Financing Water: Investing in Sustainable Growth.
[28] Note: Includes only blended finance that could be attributed to a sector (66% remains unallocated).
[29] Development Alternatives Incorporated (2012), Philippines – Water Revolving Fund Support Program.
[30] OECD, (2009) Private Sector Participation in Water Infrastructure, P14.

4. **Green bonds** are tied to the financing of specific sustainability projects, such as those that contribute to climate adaptation. Urban water projects could make a convincing case that they qualify, particularly those that contribute to SDG6. Globally, water projects accounted for USD 33 billion in green bond issuance in 2022, just under 7% of the total (Figure 10) and around 5 times less than those issued for energy projects.

Figure 10: Growing market for water-focused green bonds

Since 2016 green bond proceeds used for water projects have roughly halved as a percentage of total green bonds, despite more than tripling on absolute terms.



Source: UBS; Climate Bonds Initiative (2022), *Use of proceeds database*.

5. **Sustainability-linked bonds (SLBs)** are linked not to specific projects but to the fulfillment of key performance indicators (KPIs), a contrast to green bonds, SLBs. For example, in 2021, Aris Water issued an SLB with two KPIs—for 85% of its water sold to be recycled produced water by 2025 and 98% by 2030.[31]
6. **Improved cooperation between stakeholders** often has spill-over benefits, trade-offs, and synergies with other projects. In these cases, it pays for stakeholders to cooperate in order to optimize project design and funding terms. Projects which may not be viable based on their benefits to a single stakeholder may be viable once others are considered.
7. **Development finance** is issued by development banks, multilateral institutions, and governments. From 2016-2020, Overseas Development Assistance (ODA), a form of development finance, mobilized USD 4.6 billion in private finance—less than a tenth of the equivalent figure for energy.[32]

[31] Aris Water, (2021) Solaris Water Sustainability-Linked Bond Framework.

[32] United Nations (2023), *The United Nations World Water Development Report 2023: Partnerships and Cooperation for Water*, P164.

3.3. Prioritizing the most impactful solutions

Most cities will build up water resilience over time by prioritizing the most locally impactful solutions. There are two useful tools to help ascertain what these are: local stakeholder maps, and solution feasibility assessments.

Stakeholder mapping

Stakeholder maps are a valuable tool for clarifying stakeholder roles and responsibilities. We have mapped five groups of stakeholders against solutions covered in Section 2 (Table 2), helping cities identify and prioritize the most locally appropriate solutions.

For instance, the ability to roll out network sensors across wide distribution networks often requires well-resourced utilities. In their absence, a city may prioritize other solutions. Similarly, smart water meters (SMWs) require customers to have formalized connections to water infrastructure, enabling utilities to install them and share consumption data. However, many APAC countries have high rates of non-revenue water (i.e., leaks and informal connections) and unconnected communities—for instance, Jakarta has only 48% piped water coverage[33]—naturally limiting the usefulness of SMWs.

[to see **Table 2** please go to the next page]

[33] Ali, F. (2023) Jakarta acts to stop being the next Atlantis, The Vibes.

Table 2: Stakeholder-Solution Mapping

Stakeholders play varying roles in deploying and scaling solutions to water scarcity.

Solutions		Public		Private sector		
		Utilities*	Municipal	Corporates	Finance	Consumer
Smart	Network sensors	Installation; Implement IoT; Leak detection and response; Financing	Financing (direct, incentives); Use generated data	Sensor and data solutions	Financing (concessionary, commercial)	Enable cost recovery via bills
Smart	Smart water meter	Installation; utilize data; Consumer contact point; reduce non-revenue water	Regulatory mandating; financing (direct, incentives); municipal building roll-out	Sensor and data solutions	Financing; education (payback periods)	Private purchases; respond to consumption data
Circular	Optimized wastewater treatment	Implement tech solutions e.g. automated sampling and wastewater treatment; Financing	Regulatory mandating; education; roll-out in publicly owned facilities	Provide products/services (particularly analytical tools)	Financing (concessionary, commercial); Impact engagements	Indirect financing via customer tariffs
Circular	Building-level greywater systems	Educate customers (particularly industrial); reward via pricing	Education; regulatory mandating; financing (incentives); implement in public estate	Provide solutions and technical expertise; implement in owned/rented buildings	Financing, concessionary and/or commercial; Impact engagements	Implement in owned/ rented buildings
Integrated Systems	Stormwater absorption/ harvesting	Build out underground storage and drainage systems; Financing	Spatial planning; financial incentives	Provide products & expertise; implement in owned/rented assets	Financing; Impact engagements; Price in flood risks	Implement in owned/ rented buildings
Integrated Systems	Nature-based Solutions	Identify flood-prone areas; work with upstream partners (watershed management); implement solutions; Financing	Regulatory mandating; financing (incentives); implement in public estate	Provide products & expertise; implement in owned/rented assets, e.g., green roofs	Financing, concessionary and/or commercial; Impact engagements	Implement in owned/ rented buildings
Integrated Systems	Efficiency labelling and standards	Educate consumers	Regulatory mandating; coordinate voluntary labelling schemes	Label products (incurring menu costs) & provide expertise	NA	Adapt purchasing decisions
Integrated Systems	Desalination	System-wide planning (e.g., viable sites, grid integration); pricing structures (i.e., long-term contracts); financing	Spatial planning; owning/operating; financing (direct, incentives)	Provide products & services	Financing (cost recovery, loan structure)	Enable cost recovery via bills

** Utilities can be public/private/hybrid depending on local governance arrangement*

Source: UBS.

Feasibility score

Each solution presents feasibility challenges. For example, city states like Singapore have the regulatory powers to introduce efficiency labelling and standards, but this solution has a long lead time before it generates benefits. That reduces its effectiveness at addressing short term water stress.[34] We approached this question by attaching a feasibility score to each solution from Section 2, adapting a framework from UNEP-DHI Center (Table 3) to score each technology against five categories. The score is based on an up-to-date literature review.[35]

Table 3: Feasibility score

How to read this table: Scores are based on a literature review against each criterion, aiming to reflect 'average' implementation benefits/challenges across geographies. In reality, technologies' scores will vary by location; for instance, desalination has lower costs in coastal cities, but this isn't reflected in our scoring given the technology's generally higher costs vs. other solutions. The 'contingent factors' column offers some mitigating factors which are likely to change a technology's impact based on the city at hand.

	Solution maturity	Initial investment	Operational cost	Implementation timeframe	Potential water savings	Net score (/20)	**Contingencies**
Smart water meter	4	3	4	3	3	17	Mature distribution network; well-resourced Utilities; low non-revenue water; regulatory power
Rainwater absorption/ harvesting	4	4	3	3	3	17	Regulatory power; Pricing
Efficiency labelling and standards	5	4	5	1	2	17	Regulatory power
Building-level greywater systems	4	3	2	2	4	15	Regulatory power; Pricing
Nature-based Solutions	5	2	3	3	2	15	Regulatory power; Maintenance
Network sensors	3	2	3	2	4	14	Mature distribution network; well-resourced Utilities
Desalination	3	1	2	2	5	13	Proximity to coast; revenue model; decarbonised electricity supply
Optimized wastewater treatment	2	3	2	2	3	12	Regulatory power; Pricing

Scale description	1	Early R&D	High capex	High opex	Significant timeframe	Low and/or hard to validate
	5	Mature & widely used	Low capex	Low opex	Quick to implement	High & easy to validate

Source: UBS; Bertule, M. et al (2017), Climate change adaptation technologies for water: a practitioner's guide to adaptation technologies for increased water resilience, United Nations Environment Program Centre on Water and Environment (UNEP-DHI).

[34] A recent review found few schemes provide evidence of their impact; See Burton, A. et al (2019), Review of international water efficiency labelling, report prepared by the International Water Association Efficient Urban Water Management Group, P54.

[35] Bertule, M. et al, (2017), Climate Change Adaptation Technologies for Water: A Practitioner's Guide to Adaptation Technologies for Increased Water Resilience, UNEP-DHI; We added 'potential water savings' as an additional dimension of feasibility, to reflect each solution's contribution to water savings (based volume and responsiveness – therefore e.g. desalination scored five).

The tools send two important messages. First, the top three technologies are arguably 'low hanging fruits' that generate significant impact with low barriers to implementation. Other technologies face constraints that limit their availability for many (e.g., desalination requires coastal proximity). Second, technologies also depend on stakeholders for their success. For instance, well-resourced utilities are possibly the only actors who can roll out infrastructural solutions like network sensors. Cities without well-resourced utilities may struggle to implement such solutions.

Using the tables together arms cities with the tools to evaluate technologies on their own merit and with respect to on-the-ground stakeholders.

4. Summing up

1. Cities should adapt to climate change as well as reduce their emissions. Water is a critical but under-considered component of this.
2. Technology and approach-based solutions exist that can help ensure water-stressed cities maximize their chances of maintaining a sustainable water supply.
3. We are in the early stages of the next major technological advances in urban water management, moving towards Smart, Circular approaches.
4. Technology alone is not enough—an integrated, systems approach is needed that combines elements of new technology with proactive government action and nature-based resilience measures to minimize waste, building a robust urban water cycle.
5. Making this happen requires a mix of government action such as targets, tightened regulations and direct financing, together with other public and private financing to catalyze and scale change.

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