WORLD GREEN BUILDING COUNCIL

Building a water-resilient future for everyone, everywhere

Examining the role of the built environment in mitigating the global water crisis

CIRCULARITY ACCELERATOR

About the World Green Building Council

The World Green Building Council (WorldGBC) is the largest and most influential local-regional-global action network, leading the transformation to sustainable and decarbonised built environments for everyone, everywhere.

Together, with 75+ Green Building Councils and industry partners from all around the world, we are driving systemic changes to:

- Address whole life carbon emissions of existing and new buildings
- Enable resilient, healthy, equitable and inclusive places
- Secure regenerative, resource efficient and waste-free built environments

We work with businesses, organisations and governments to deliver on the ambitions of the Paris Agreement and UN Global Goals for Sustainable Development (SDGs).

The WorldGBC's Circularity Accelerator programme aspires to create a built environment with net zero whole life resource depletion, working towards the restoration of resources and natural systems within a thriving circular economy.

worldgbc.org/circularity-accelerator/

WorldGBC's Circularity Accelerator is kindly supported by:

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> "Everyone should be able to access safe, clean water. It is one of the most fundamental requirements to sustain our lives. Yet we find ourselves in a time where this requirement is now in serious jeopardy. We must take a systems change approach and utilise every resource and opportunity to drive real change across global infrastructure."

Cristina Gamboa, CEO, WorldGBC

1.0 Introduction

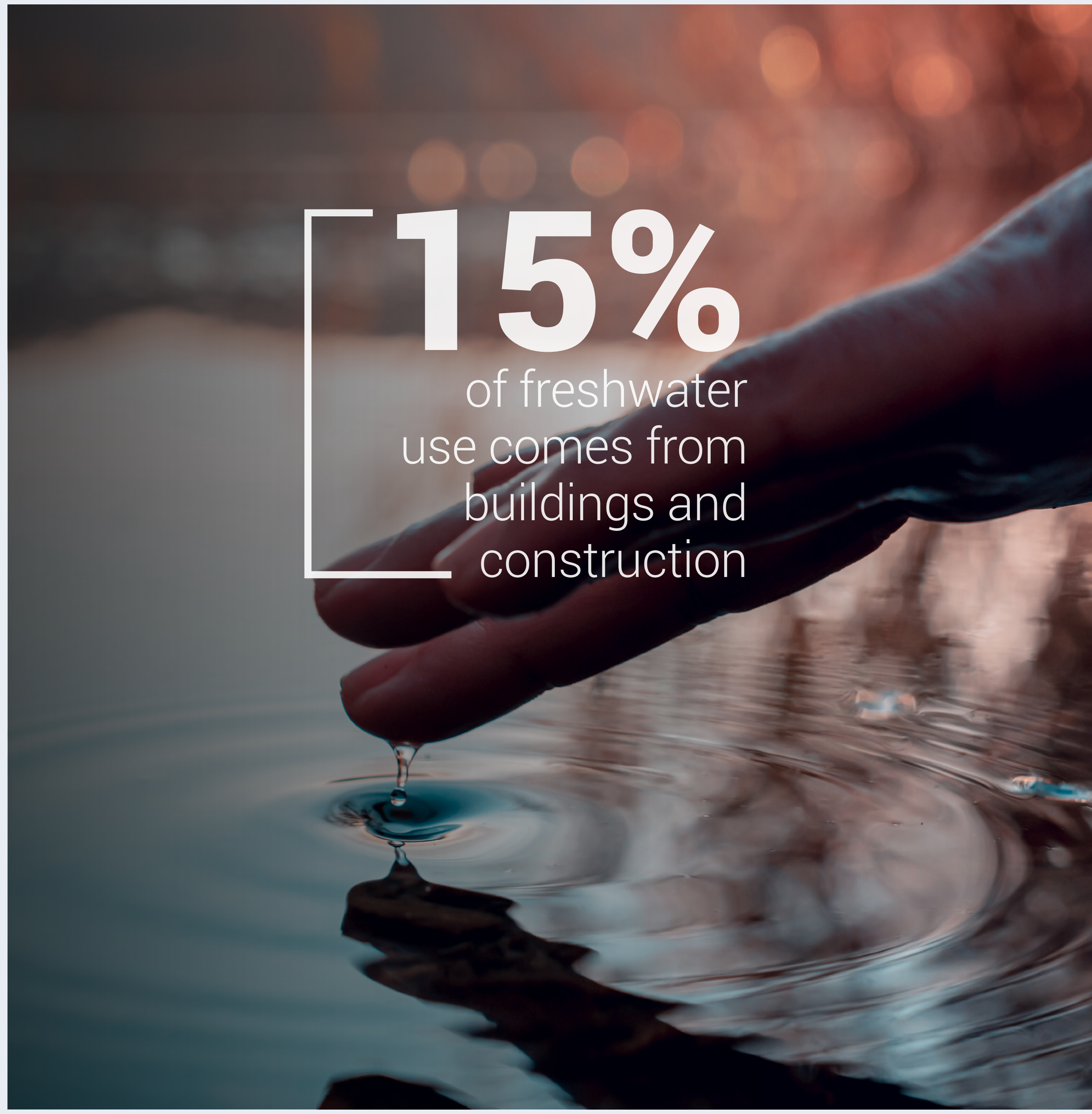
The global water crisis is an escalating problem that demands urgent attention. It is predicted that by 2030 there will be a 40% gap between global water supply and demand.[1] With buildings and construction estimated to be responsible for around 15% of the freshwater use,[2,3,4,5] it is imperative to assess the role of the built environment in contributing to and mitigating this crisis.

This paper highlights the urgent challenge with water in the built environment by presenting the magnitude of the global water crisis and outlining the role of the built environment as a contributory sector.

We also reveal the four challenges of the global water crisis and present both the contribution and the critical role the built environment sector must take in mitigating them.

Through this publication we aim to support policymakers, planners, developers, designers and manufacturers to recognise the urgency to develop sustainable strategies to promote water conservation, efficiency and equitable access through circularity principles such as prevent, measure, reduce, reuse and restore.

This paper has been developed by WorldGBC in collaboration with a network of 26 Green Building Councils around the world, our partners Brightworks Sustainability, CBRE, Foster + Partners, WSP, Kingspan, ARKANCE (formerly VinZero) and Arup, and a network of 40 individual experts.



2.0
The magnitude of the water crisis

Although the surface of the planet is approximately 70% water, less than 1% of the water on Earth is available for human consumption and use.[6] As a fundamental resource for all life on the planet, its efficient and equitable use is therefore a critical component of sustainable development.

However, in the past century population growth, industrialisation, urbanisation and climate change have collectively contributed to a rapidly accelerating global water crisis. Today, nearly four billion people are affected by water scarcity,[7] and predictions suggest this number will only rise as global water demand is projected to increase by 55% by 2050.[8]

Water and the built environment

The built environment is a major water user through all stages of the lifecycle, in addition to the water consumed by people in their homes and communities. However, in the next four decades, we will experience the largest wave of urban growth in human history – emphasising that the actions of the building and construction sector will be critical to mitigating the impact of the global water crisis.

The amount of global building by floor area is expected to double in size by 2060 – meaning an urban area the size of New York City is being built every month.[9,10] This will undeniably heighten the existing pressure on water availability – leading to further depletion of finite resources, in accompaniment to the greenhouse gas emissions and wider resource use.

Water is an environmental factor that is frequently overlooked, but with 79% of Nationally Determined Contributions (NDCs) mentioning water as a top adaptation priority,[11] it is clear the global water crisis is gaining increased attention at the highest political spheres.

In the face of this critical transition, it is urgent that the building and construction sector takes action now to protect, preserve, and enhance the global water supply – or risk creating a future facing even greater resource crises than today.

3.0
The four challenges of the global water crisis

40%
gap between global water supply and demand by 2030.

As the global population increases, many countries' water resources and infrastructure are failing to meet accelerating demand.

90%
of natural disasters are water related.

The increase in extreme weather events is having a global effect, but vulnerable communities are at higher risk.

1/4
of the global population does not have access to safe potable water.

Universal access to clean, fresh water is one of the main challenges that societies face in the 21st century, threatening human health, and hindering economic growth.

10%
of global greenhouse gas emissions come from global water use, storage, and distribution.

Greenhouse gas (GHG) emissions are generated by supplying water due to energy requirements for pumping, treating, desalination, distribution and waste management processes.

3.1. Water scarcity

As the global population increases, many countries' water resources and infrastructure are failing to meet accelerating demand.[12]

Currently, two-thirds of the global population (four billion people) live under conditions of severe water scarcity for at least one month of the year, and nearly two billion people live without access to safe water.[13] Close to 70% of global territories are currently experiencing water stress (i.e. when more than 25% of its renewable freshwater resources are withdrawn)[14] – and these trends are only worsening.

Predictions suggest that by 2030 there will be a 40% gap between global water supply and demand.[15] In the context of growing global population and resource demand, the risk of these life-threatening water availability issues will rise in all regions of the world.

Africa is the continent where the impact of water scarcity is the highest. In ten African countries, half of their populations do not have access to potable water and sanitation.[16] In 2018, South Africa's Cape Town called worldwide attention to the water crisis by showing that it was heading towards Day Zero – the day when a city runs dry, forcing people to collect daily quotas of water.[17]

Find out more about WorldGBC's vision for sustainable water use in Africa within the *Africa Manifesto for Sustainable Cities and the Built Environment*.

As a fundamental, and yet scarce, resource for the development of our societies, potable water needs to be valued and protected by all regions of the world.

3.2. Water equity, access and quality

Universal access to clean, fresh water is one of the main challenges that societies will face during the 21st century, threatening human health, and hindering economic growth.[18]

Over one third of the world's population has access to less than 10% of its water,[19] with huge global disparity in national water footprints per capita — United Arab Emirates and United States use more than double the water per person than Nigerian and Indian populations.[20]

Around a quarter of the global population does not have access to safe potable water, and almost half lack proper sanitation services.[21] Contaminated drinking-water is estimated to cause over half a million deaths each year.[22] In developing countries, water scarcity issues merge with inadequate infrastructure, leading to the presence of bacteria, viruses, and parasites in the freshwater stores. This is resulting in over a hundred deaths every hour in Africa.[23]

The presence of pollutants in potable water is rising in all regions of the world,[24] which is linked to long-term health effects.[25] The proportion of the global population predicted to be exposed to water pollution (salinity, organic and pathogen pollution) by the end of the century ranges from 10-20%, disproportionately affecting people living in developing countries.[26] Additionally, where local infrastructure is not sufficient, the exploitation of freshwater pricing to vulnerable populations can lead to a doubling of cost,[27] and a consequential further lack of access.

Prioritising access to potable water in vulnerable communities can present wider co-benefits, including poverty alleviation. The lack of access to safe water and sanitation perpetuates poverty cycles, and gender equality as women and girls often bear the responsibility of fetching water and managing household sanitation.

Access to safe water and sanitation is a basic human right, and a critical step towards achieving sustainable development and social justice.

> Around a quarter of the global population does not have access to safe potable water

3.3. Greenhouse gas emissions

GHG emissions are generated by supplying water. This is due to energy requirements for pumping, treating, desalination, distribution, water treatment and waste management processes.

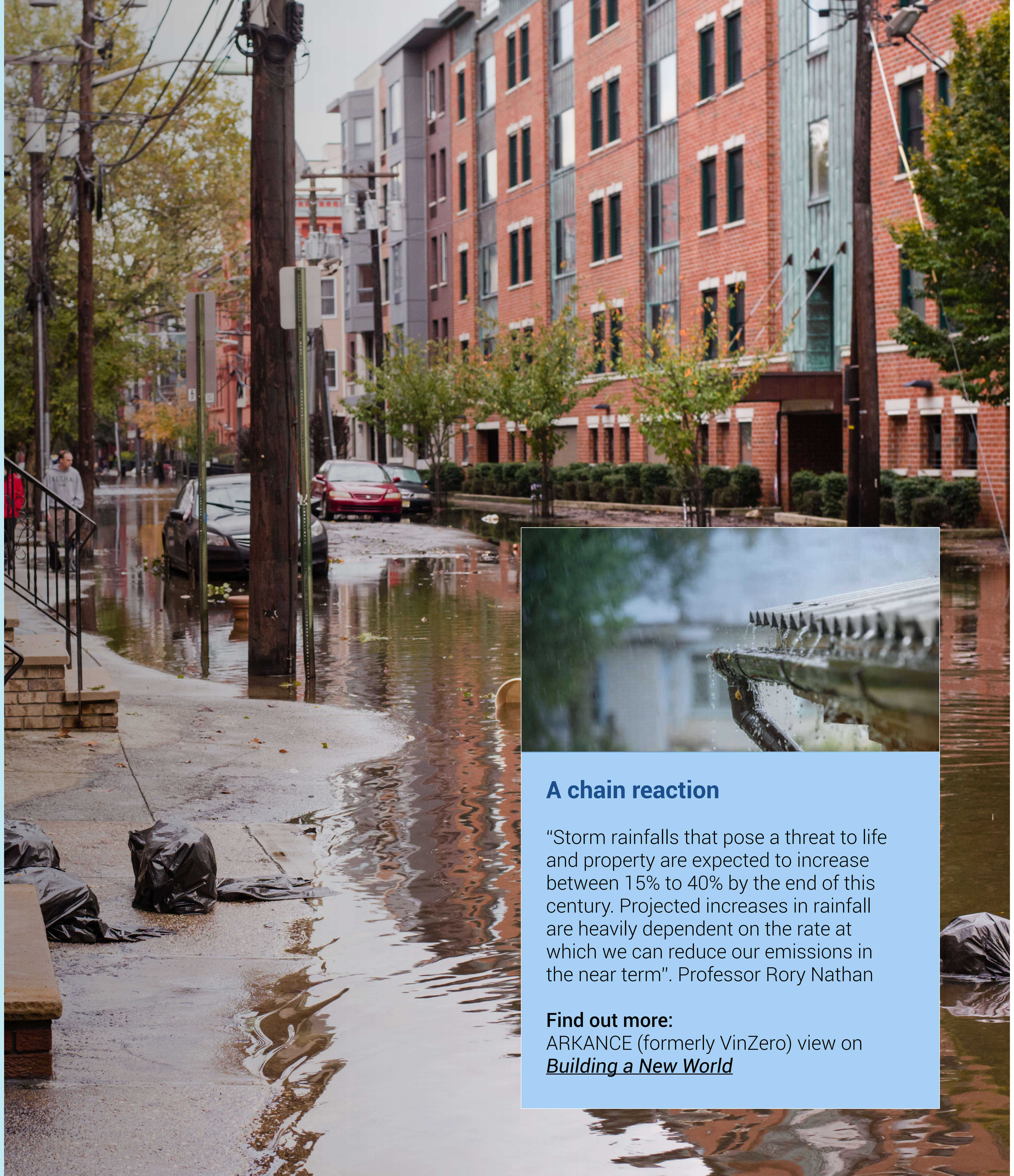
Global water use, storage, and distribution contribute 10% of GHG emissions.[28]

Although desalination is key to providing water to certain regions, such as the Middle East and North Africa, converting seawater into freshwater is an energy-intensive process and can contribute significantly to emissions if the energy comes from fossil fuels. An estimated 76 million tons of CO_2 equivalent are emitted annually as a result of desalination processes, (alongside the 142 million cubic metres of brine – including leftover salt and chemicals – that are returned to the sea every day as a by-product of desalination, causing immeasurable damage to marine ecosystems).[29]

The energy sector also uses huge quantities of water – roughly 10% of total global freshwater withdrawals, with the highest consumption attributed to fossil fuel extraction and combustion. The total amount of water usage for energy is expected to increase by more than 10% by 2030.[30]

Water and energy are two global resources that both need to be used far more sustainably, and as these two sectors are inextricably linked, efficiency measures must be united across these industries.

Read more about the Water-Energy-Carbon Nexus in our homes.



A chain reaction

"Storm rainfalls that pose a threat to life and property are expected to increase between 15% to 40% by the end of this century. Projected increases in rainfall are heavily dependent on the rate at which we can reduce our emissions in the near term". Professor Rory Nathan

Find out more:
ARKANCE (formerly VinZero) view on *Building a New World*

3.4. Resilience and climate change

Extreme weather events, including droughts, periods of excessive precipitation and flooding are heightening in both frequency and severity as a result of climate change.[31]

Over 90% of natural disasters are water related.[32] Droughts and floods account for more than 20% of the economic losses caused by extreme weather events in the US each year,[33] while in the Asia Pacific region economic damage from droughts and floods has increased by 63% and 23% respectively in the last 20 years, affecting around 50 million people and causing economic annual losses of over US$ 30 billion.[34]

Although the increase of such events will have a global effect, vulnerable communities are at higher risk. Enhancing water and sanitation infrastructure can help these communities build resilience to climate-related challenges.

Furthermore, the inefficient use and disposal of fresh water has posed a threat on biodiversity; the combined impact of escalating water abstraction rates, flow modification, increased nutrient loads and pollution, among others, are increasing the loss rate of animals and plants, especially on wetlands. Faster action will be needed in the following years to challenge current consumption and protection patterns.[35]

See WorldGBC's *Climate Change Resilience in the Built Environment.*

4.0
The role of the built environment

The built environment provides the physical infrastructure that forms the basis of our societies and economic development. However, the lack of water protection and preservation practices has caused significant contributions from the sector to the global water crisis.

Tackling these existing challenges, as well as providing safe water to the world's growing population, is a key responsibility for the building and construction sector – in line with the urgency to decarbonise the industry by 2050.

Our cities and communities are where the water crisis is felt – with 14 of the world's 20 megacities experiencing water scarcity or drought conditions.[36]

The need for change from the building and construction sector is apparent at all stages of the supply chain, and reflected across four geo-spatial scales of water use in the built environment industry:

- Supply chain
- Construction processes
- Buildings
- Cities and communities

The four scales of water use in the built environment

Supply chain

The industrial sector is the second largest water user in the world.

Water in the manufacturing of building materials and products is used in indirect processes such as energy production, and direct processes including chemical reactions, cooling, cutting and washing.

Construction processes

Water is used abundantly in processes such as mixing concrete, dust control, equipment operation, landscaping and worker amenities.

Therefore, it is essential to prioritise the efficient use of freshwater on site, together with reuse and recycling technologies.

Buildings

The consumption and conservation of water within individual buildings can have significant environmental, economic and social impacts.

Key challenges include lack of monitoring, inefficient fixtures and systems, inadequate maintenance, and lack of awareness or incentives.

Cities and communities

While citizens require direct water for basic needs such as drinking water, cooking and cleaning, our municipal utilities and services also require freshwater.

Urban centres often face problems related to insufficient infrastructure, water consumption and loss, wastewater management, and water drainage.

4.1. Water consumption in the supply chain

The industrial sector is the second largest* water user in the world.[38] Most of the water used during manufacturing processes cannot be directly reused for other purposes[39] – and additionally presents a contamination risk to local water.

Water in the manufacturing of building materials and products is used in indirect processes such as energy production, and direct processes including chemical reactions (such as the hardening of cement), cooling, cutting and washing.[40]

The embodied water in construction products and materials varies geographically, with limited quantified data (most reporting has been limited to factory operations).[41,42]

However studies show that wood, concrete and cement are the products with the highest consumption of water,[43,44,45] as shown in *Table 1*.

* Crop and animal products are responsible for the largest amount of water consumption in the world.

The environmental footprint highly depends on the location of the resources and the project, therefore decisions about the material selection should be made under comprehensive lifecycle analysis that allow the comparison of the different environmental impacts and any potential trade-offs.[46]

Category	Material	Water demand (litres / kilogram (l/kg))
Stone-like	Bricks	1,890
	Concrete	2,045
	Reinforced concrete	2,768
	Cement	3,937
Metals	Steel	78
	Aluminium	214
Wood products	Oriented Standard Board (OSB)	25
	Softwood timber	5,119
	Laminated timber	8,366
Insulation	Cellulose fibre	21
	Cork slab	30
	Rock wool	33
Miscellaneous	Roof tile	3
	Glass	17
	PVC	512
	Lithium (used in batteries or products such solar panels)	2,273

Table 1: Water consumption by material.[47] Individual footprints are estimates only and may highly vary according to the geographical context.

Embodied water

Embodied water, also known as the water footprint, is the amount of water required to manufacture products, including the extraction of raw materials, processing, manufacturing and transportation. This includes both non-energy and energy-related water use.[37]

Water and the circular economy

This white paper by Arup, Anteagroup and the Ellen MacArthur Foundation sets out a theoretical basis to apply circular economy to water systems. It explores the relationship between the principles of circular economy and sustainable water management, establishing a common language to enable effective communication between circular economy and water management practitioners.

It explores specific ways to design out waste externalities, keep resources in use and regenerate natural capital throughout the water supply chain, exploring the dimensions of water "as a service", "as a carrier" and "as a source of energy".

4.2. Water consumption at the construction phase

Water is used abundantly during the construction process, as it is required in large volumes for tasks such as mixing concrete, dust control, equipment operation, landscaping and worker amenities.

Since the construction phase is short within the life cycle of a building, the tracking of water consumption has not been a common practice. Some studies have estimated this consumption in the range of 500 to 3,500 litres per square metre of constructed floor area,[48] with the highest uses being attributed to dust control (especially in demolition projects), earthworks, cement plastering and welfare facilities.

As building certifications, ESG frameworks and policies – such as the EU Water Framework Directive – arise, contractors and developers have expressed their commitment to track and use water more efficiently.[49] Rainwater harvesting should be considered for construction activities to manage stormwater on site while preventing pollution and reducing the use of freshwater.

4.3. Water use at building scale

Problems from water use and efficiency at a building level can have significant environmental, economic, and social impacts.

Key challenges that reduce or prevent the efficient use of water in buildings include:

- **Lack of submetering, monitoring and data:** Submetering is not a common practice, except for buildings due to have a sustainability certification. Without the necessary monitoring systems to track water consumption and identify inefficiencies, it is challenging to identify wastage or leaks and make informed decisions about conservation measures.
- **Inefficient fixtures, appliances and plumbing systems:** In existing buildings, outdated or suboptimal fixtures can consume excessive water. Older buildings with outdated plumbing systems are prone to leaks, inefficiencies, and water loss.
- **Inadequate use and maintenance plans:** Water systems in buildings require regular inspections to prevent losses, damages, and diseases such as legionella.[50]
- **Behavioural factors:** User behaviour plays a critical role in driving water efficiency in buildings. Lack of awareness about water conservation, poor habits, and indifference can contribute to excessive use.
- **Systemic disincentivisation:** In some countries such as Canada, Norway, and the United Kingdom, fixed water charges are commonly found, and therefore the fiscal incentives to save water for the consumer are low.[51]
- **Low adoption of harvesting and recycling technologies:** Rainwater harvesting, while mandatory in some regions, is still not common.[52,53] Greywater recycling is another option, however this is not commonly found in building or infrastructure projects.

Reusing grey and black water

Greywater is wastewater with low levels of contamination and therefore it can be easily treated and reused on site. It usually comes from sinks, washing machines, bathtubs and showers.

Blackwater is highly contaminated wastewater that requires biological or chemical treatment and disinfection, before being reused. It usually comes from toilets and kitchens.

It is estimated that high-efficiency plumbing fixtures and appliances could save about 40% of indoor water use.[54, 55] This alone, in US federal buildings, could save as much as USD$ 240 million per year and provide enough water to supply a population of approximately 1.8 million.[56]

The 50L Home Coalition and the circular water economy

The *50L Home Coalition* is a global action-oriented platform whose mission is to reduce household water consumption to 50 litres per person per day by building systemic resilience, encouraging water and energy efficiency in households, and generating awareness that leads to more sustainable water use.

4.4.
Water use in cities and communities

Water infrastructure is one of the most fundamental urban systems in operation that provides life-giving services to residents. Urban centres face problems related to water consumption, wastewater management and stormwater runoff.

While citizens require direct water for basic needs such as drinking water, cooking and cleaning, many services including power generation, fire-fighting and irrigation require freshwater.[57] The main challenges at city level include:

- **Insufficient infrastructure** is an urban water challenge faced in almost all geographies. While many nations in the world still lack access to clean water sources and sanitation infrastructure,[58] even in the most developed regions, water leakages caused by ageing infrastructure and losses during distribution can lead to water loss, as well as increased energy consumption for pumping and treatment.[59]
- **Water loss** due to leaking pipe networks is one of the largest challenges facing the potable water industry. Globally, up to 30% of treated drinking water is lost prior to reaching a tap. Conservative estimates put such losses at approximately US$ 40 billion worldwide annually.[60]
- **Water drainage** represents an additional urban challenge as runoff is a critical risk factor of water damage. Cities are primarily hard surfaced, meaning water does not infiltrate back into the soil, and consequently groundwater supplies and aquifers are not replenished. Cities are therefore places of high net extraction – with increasingly low replenishment as greater areas are urbanised.
- **Regulations** could represent an obstacle in certain locations like in the United States. Certain practices, such as water harvesting, may have legal limitations due to health, land use and building code regulations, or ownership of water rights.[61, 62]

More than 1 trillion litres lost via leaky pipes in a year in the UK

Water companies in England and Wales lost more than 1 trillion litres via leaky pipes in 2021, equivalent to 427,000 Olympic swimming pools, and affecting 15 million customers.[63]

Due to the magnitude and frequency, local environmental agencies began penalising and prosecuting water companies for causing environmental damage. Over the last 20 years, over £300m in fines have been imposed.[64]

Infrastructure can and must be part of the solution. Options such as rainwater capture and sustainable urban drainage offer low-cost mechanisms to reduce rainwater loss to the sewerage systems and reduce risk of surface water runoff and damage. There is also a potential for AI applications to support processes that can be automated and identify leaks.[65]

Water Sensitive Urban Design (WSUD)

Water Sensitive Urban Design (WSUD), also known as low-impact development (LID), or Sustainable Drainage System (SuDS),[66] slows the flow of stormwater through the urban system by improving capacity for absorption and retention in the landscape. This reduces the risk of flash flooding and relieves stormwater infrastructure during extreme weather events.

WSUD provides a range of benefits and ecosystem services including increasing native biodiversity, providing air filtration and pollution reduction, harvesting rainwater and improving stormwater quality.[67]

Case study – Nature-based desalination

An Australian-first water treatment project, Booth Transport used new technology to combine nature-based solutions, through the use of a worm farm as a water filter, and desalination.

Find out more:
Sustainable Australia Fund

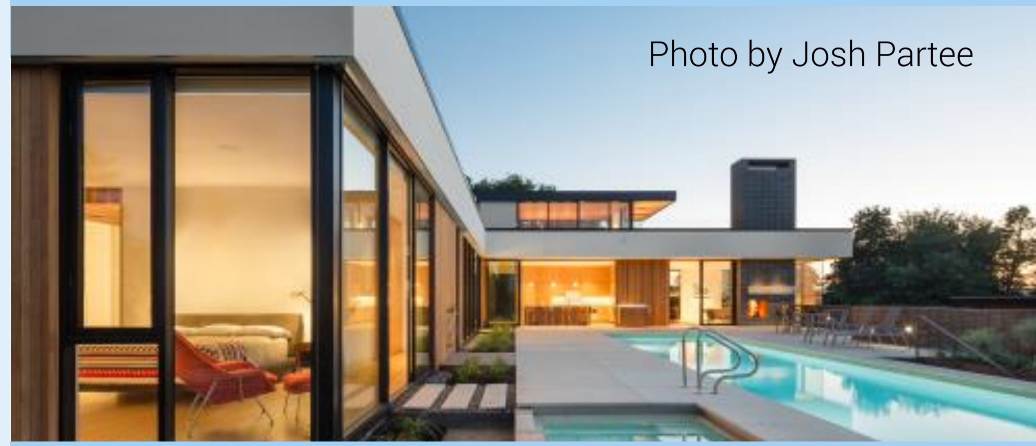


Photo by Josh Partee

Case study – Innovative local rainwater collectors

Ash + Ash Rainwater Capture & Reuse system has 9,000 litres of storage collects, filters, and purifies rainwater for domestic and potable use — greatly minimising water consumption by taking advantage of Portland's abundant natural rainwater.

Find out more:
Brightworks Sustainability and Hennebery Eddy Architects

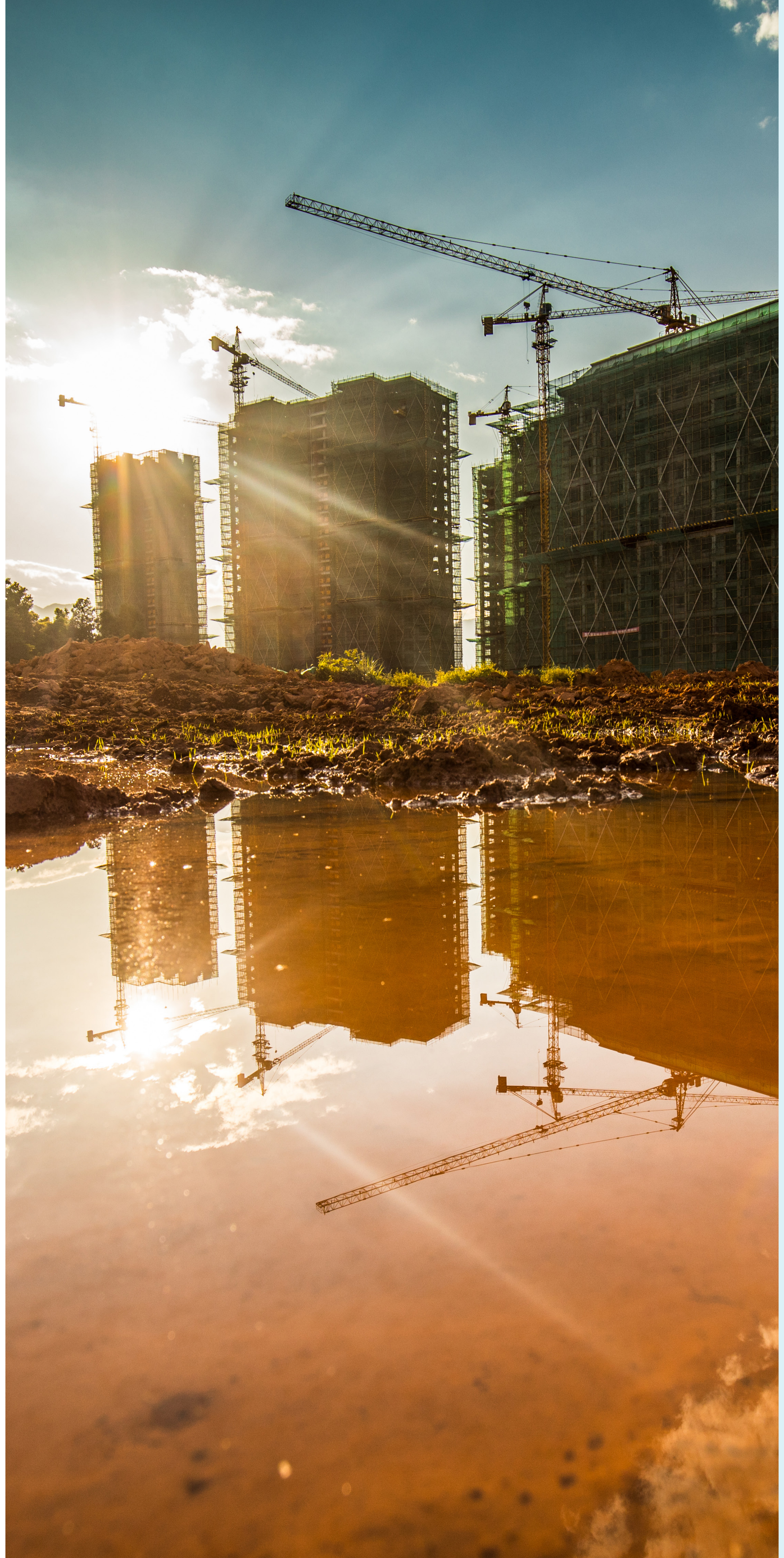
5.0

Actions for the building and construction industry

Fresh water is a precious resource that is essential for the existence of all nature — the need for which is only increasing as water scarcity, extreme weather events and global populations all increase. The lack of systemic and long-term planning has caused a global water crisis that is being further exacerbated by climate change.

The built environment provides the physical infrastructure that forms our homes, workplaces, communities and societies. The role of the built environment is not only to provide safe, quality water for all but to guarantee a sustainable future for the world's growing population.

All stakeholders in the value chain, from suppliers to regulators, have a responsibility to enable sustainable and equitable development and social justice. As a sector, we need to recognise the urgency of this challenge and understand where the greatest risks and opportunities can be found across the lifecycle so that appropriate water strategies can be developed and implemented.



Principles of Water Management

To optimise resources, these water management principles guide the prioritisation of measures, starting by preventing unnecessary uses and promoting appropriate disposals without endangering human health or harming the environment.

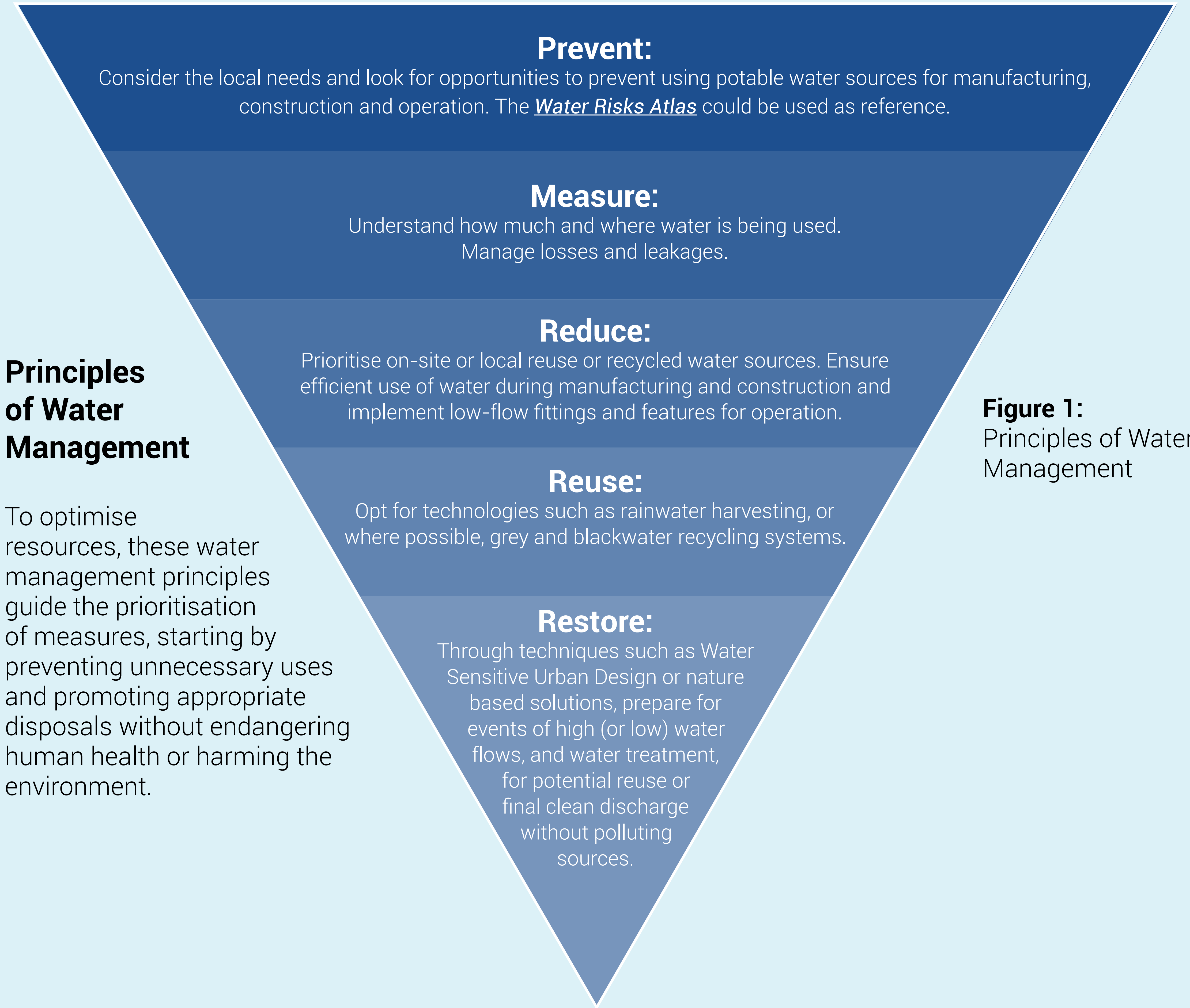


Figure 1: Principles of Water Management

We recommend following the steps outlined in the Principles of Water Management in *Figure 1*, which align to the numerous global rating tools and certifications that provide guidance for water efficiency in the built environment, such as *LEED*, *Green Star*, *DGNB*, *BREEAM*, *EDGE*, *Living Building Challenge*, *WELL Building Standard*, among others and initiatives such as the Valuing Water Corporate Expectations and Measuring Water Circularity.

WorldGBC provides a Case Study Library of best practice examples and case studies from around the world, which aim to raise industry ambition and demonstrate what can be achieved.

Additionally, please refer to our Global Policy Principles for further recommendations to conserve and protect water resources and the Efficient water management: from building to city scale.[68]

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