

The Future of Water

The Global Challenge

Climate change, population growth and increased urbanization pose great challenges to the provision of water for human use. Since 1950 cities have increased their water usage fivefold, not only through population growth, but considerably through increased per capita demand. Currently half of the world's cities with more than 100,000 inhabitants are situated in areas experiencing water scarcity¹. To date neither governments nor businesses have done enough to prepare for this. Collectively we did not recognize the macro trends soon enough and so opportunities to counter water scarcity have been lost, infrastructure investments have been inadequate, and climate change adaption measures too local and often only reactive.

At the same time as access to water

decreases, world energy consumption is projected to grow by 56% between 2010 and 2040. This matters because approximately 90% of global power generation is water intensive so a country's energy mix has fundamental implications for its water industry. Water security has therefore become one of the most tangible and fastest growing social and economic challenges faced today.

So, how can we meet the water needs of the future? Will it be possible to provide equitable access to water and sanitation services when by 2030 the world will face a 40% global shortfall between forecast demand and available supply?² Can we make the water cycle respond to the challenges of climate change and energy need? How can we do more with less water?

Ready for Water Scarcity

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The Supply / Demand Challenge

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Options and Possibilities

The UN has sagely noted that "water is the primary medium through which climate change impacts will be felt by humans, society and the environment" and accordingly climate change will necessitate improvements in water resilience systems in cities across the globe. Increasingly they will have to focus on local water sourcing, reuse and recycling in order to sustain their ever-expanding population. There are multiple

ways in which efficiency can be improved not least through significant investments in green infrastructure, the adaption of smart technology and widespread public education which will help to manage water demand through a broader understanding about its natural process. Water is a key contributor to life. We need to be constantly reminding ourselves of this and take action.



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Desalination Essential

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Data Analytics

Data analytics can help build understanding on how to use the water cycle to respond to the challenges of climate change. It can also lead to increased scrutiny of water utilities and a better understanding of cost.

Many countries are currently working to maintain and improve the quality of their sources. About 96% of the earth's total water supply is found in oceans and there is broad agreement that extensive use of desalination will be required to meet the needs of growing world population. Worldwide desalination plants are producing over 323 million cubic metres of fresh water per day, however energy costs are currently the principal barrier to its greater use. The State of Singapore has innovative water technology, aiming, despite its size and population density, to become fully self-sufficient by 2061. Plans include tripling its desalinated water supply by 2030, the large-scale collection of rainwater, and the collection of recycled water which, as well as the standard procedures, uses micro filtration processes, reverse osmosis and UV treatment to deliver potable water to its citizens. In short they are converting their city into a catchment and focusing on source diversity.

Elsewhere efficiencies will be improved by the use of intelligent robots, which will play a greater role in the inspection of infrastructure. New materials, such as graphene, that are lighter, stronger, smarter and greener will also become more popular replacing traditional materials such as stainless steel pipes.

Growing concern for the environment and for public health means that water companies will be held to greater account for their environmental impact and water quality. A stronger emphasis on green infrastructure will support a trend for companies to transform from providing base utilities to creating a system of amenities that support the water cycle. An example of this can be found at the Illinois Institute of Technology. Rain gardens have been reutilized as communal meeting spaces, through-ways turned in to permeable walkways and three acres of new native plant communities with underground cisterns collect rainwater for future non potable reuse. Once all the changes are implemented the IIT predicts a 70 – 80% reduction of run-off into Chicago's sewer system while making the collected non-potable water available for irrigation. Expect this repurposing of public spaces for

multi-functionality for both amenity and wider sustainability purposes to be widely adopted.⁴

Alongside making improvements to the infrastructure, there is a pressing need to do more with less water. Smart technology and big data will help. Changing public behavior is a huge challenge however. Although there is widespread understanding that rising consumption of raw materials is both intensifying resource scarcity and increasing competition, most people, certainly in the developed world, live materialistic lifestyles resulting in high levels of waste. In Australia for example, on average around 20 million tonnes of waste per year is thrown away at a value of AUD10.5bn. Digital lifestyles can increasingly link consumer behavior to consumption and growing connectivity, utilizing the Internet of Things, will mean that it will be possible to monitor the consumption and cost of water in real time allowing consumers to understand their impacts and take action.

Data analytics can help build understanding on how to use the water cycle to respond to the challenges of climate change. It can also lead to increased scrutiny of water utilities and a better understanding of cost. Companies will therefore be able to integrate the true cost of water into their decision-making. In addition the availability of data provides an opportunity to educate customers about consumption. Publicity campaigns and a growing sense of urgency will nudge consumers to reduce consumption and should be used in partnership with economic levers that recognize the true value of water.

Growing populations and changes in diet mean that we need to produce more food. Water is a fundamental part of this process. In Australia, for example, the agricultural sector accounts for around 65% of total water consumption. This could be greatly reduced if we could change consumer behaviour. It is estimated that Australians throw away AUD5.3bn of food waste every year. This is simultaneously wastewater. There is a real need to change this approach and developments in this sector will continue to

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have tangible knock on effects for the water supply industry and the natural environment from which this water is sourced.

Science will also have a key role in reducing the amount of water we use. Nano and biotechnology is a potential game-changer for the water industry, and can enable breakthrough products and technologies to tackle pressing global challenges such as reducing environmental footprints, using less and cleaner energy and decreasing water usage and waste generation. For example microorganisms are now being used to treat water that has been contaminated by hazardous materials. The global market for nanostructured product used in water treatment was worth an estimated USD1.4bn in 2010 and is expected to rise to USD2.1bn in 2015.³ Initial success in this area has also raised the possibility of the utility as a self-healing ecosystem.

Greater efficiency is the driving force for manufacturing companies where energy and water can be as much as 50% of the total manufacturing cost. In the future expect more green manufacturing and increased co-operation when companies forge alliances across traditional boundaries, for example to share common costs. In the water industry this will manifest itself in knowledge sharing and contributions to joint research and development across catchment boundaries. Through using resources more efficiently countries could also become more active trading partners; this would allow for more equal water redistribution amongst users. This could include a water balance concept similar to carbon emissions reduction strategies where water saved in one country offsets additional water use in another.

Looking ahead, users are likely to have to pay for the real cost of infrastructure. One short-term option is the financial recycling of assets and capital where old assets are sold or leased to fund the new. However, in the longer-term we will have to pay the true value for key resources. This shift could also lead to the greater application of the circular economy, which will help stretch resources through end of life recycling and reuse. More awareness will lead to increased scrutiny

of water utilities and pricing of services as the widespread availability of data provides the opportunity to educate customers about consumption and managing resource use. Looking through an international lens, water trading would allow for the efficient redistribution of water amongst users, so countries could become active trading partners. As the amount of water used in agriculture in arid regions is two to three times higher than in rain fed regions water trade could help save water on a global scale.

Once efficiencies and improvements are made, consideration should be given to the most cost effective way to provide access to basic services. The fixed nature of water supply infrastructure and its history as an essential government supplied service gives rise to natural monopolies within supply areas. Governments need to ensure the pricing policy is appropriate to balance the essential need for water, the impacts on consumers (particularly those on lower incomes) and the requirements of the suppliers to remain financially viable. To do this there should be better integration between urban water planning and urban development planning with considerations on limitation to green-field development.

Recognizing innovation opportunities for the future more and more companies are tapping into the public's intellectual capital by crowdsourcing product ideas and solutions. In exchange they are giving creative consumers a direct say in what gets developed, designed or manufactured. Crowd-funding added at around 270,000 jobs and injected more than US\$65bn into the global economy by the end of 2014 with an expected industry growth of 92%.

Real Cost of Water

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Proposed Way Forward

Moving Water

Over the next ten years our waterways and other water sources will continue to suffer from over-extraction. This will continue to compromise the quality of the environment and the organisms it supports. In particular mining and other activities will continue to move into our water supply catchments affecting water quality and altering inflows. This will mean that we may be obliged to move water long distances in times of drought to services existing cities.

Doing More with Less

The focus should extend to solutions that do more with less: irrigation efficiency, automated farming techniques and demand management in our cities. Smart infrastructure will help responding intelligently to changes in its environment to improve performance.

The Funding Challenge

Water treatment can come at a high price. The OECD has estimated that around USD50 trillion would be needed worldwide in the period to 2030 to satisfy the global demand for infrastructure. However, accessing funding is an ever-present challenge.

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We need to change this trajectory. In doing so it is important that we reconnect ourselves with water in its pure elemental form. We should all be able to enjoy access to clean water, not just for drinking, but also for recreation and connection to nature. Putting water at the centre of the urban design process and re designing our cities and towns to respond positively to water is fundamental to ensuring a better understanding of the water cycle. We need to develop better Green infrastructures - the networks of green and blue spaces such as parks, agriculture, woods, rivers and ponds in and around cities systems - that replicate nature and enable communities to connect with water. The benefits include the reduction of flood risk, improved health and well being as well as providing a habitat for wildlife. Extensive green networks can be formed over time to create encompassing city ecosystems that can support the sustainable movement of people, rebuild biodiversity and provide substantial climate change adaption and resilience.

The focus should extend to solutions that do more with less: irrigation efficiency, automated farming techniques and demand management in our cities. Smart infrastructure will help responding intelligently to changes in its environment to improve performance. Smart water networks could save the industry USD12.5bn a year. In Israel, data analytic company TaKaDu takes information supplied by sensors and meters dotted around a water company's supply network to build a sophisticated picture of how the network is performing. It can spot anomalies in its behaviour from a small leak to a burst water main.

We should also start to re-think our traditional approach to drainage. Working with natural site conditions for example, water, wastewater and storm water could be combined into one cycle. The AJ Lewis Centre for Environmental Studies ecologically treats and recycles wastewater within its buildings, integrating processes of wetland ecosystems with conventional procedures and in so doing recycling wastewater into reusable grey water. While conventionally supplied water is used for drinking and hand washing, the recycled non-potable water is used in the Centre's toilets and for landscape irrigation and recharging the wetland pond. Others should and are following suit.

A multitude of new tools are available to help us. Alongside smart technology there are new biodegradable materials made from natural fibres that can provide greater resilience at less energy and lower cost. Beyond this, innovations will transform wastewater into a resource for energy generation and humidity into a source of drinking water. We can see the beginnings of this already; consider, for example, the Israeli company, Water Gen, which has developed a device for extracting drinking water from air. Other advances including fog catchers, thick mesh nets that collect the water contained in fog, will soon be more widely adopted.

We need increased investment in basic water and sanitation services both in new and the renewal of existing services. Water treatment can come at a high price. The OECD has estimated that around USD50 trillion would be needed worldwide in the period to 2030 to satisfy the global demand for infrastructure⁵. However, accessing funding is an ever-present challenge. In the US alone, if current trends continue, the investment needed by 2040 will amount to USD195bn and the funding gap will be USD144bn⁶. While most infrastructure investments are local, the sources of finance are increasingly global.

Beyond everything we must improve public understanding about the value of water and the services it provides. Globally public opinion still varies on the issue of climate change. Better engagement with customers including education and information

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will have a large effect on calls to action around water. Education is fundamental to help the public to accept the need to reduce overall water use and to increase the use of wastewater for potable purposes. In particular city dwellers must learn to

conserve more or utilize different sources of water such as storm water to provide for their needs, allowing potable water to be freed up to feed a growing population. Small adaptations by multiple individuals will make a difference.

💧 Impacts and Implications

In the future it is clear urban water utility companies must prepare to operate in a world which is expected to be utterly different from the one that we are experiencing today. It is necessary to acknowledge and prepare for this.

We know that there is a growing urban population; we know that the impact climate change is now taking effect and that the volatility in water supply can only be partially mitigated by improved efficiency. We have yet to collectively decide how to address the problem.

Water is inter-twined with everything we do; energy, food, health and wellbeing, manufacturing are all dependent on its availability. At the very least we need to start a public conversation about its real role in

our lives. We need to understand how people currently value water and then work with them so they understand its true value and all the services it provides.

Providing access to water is one of the greatest challenges we face and one of the defining moral and cultural issues facing the planet. To address it governments must develop national water strategies, businesses must consider the impact of water in their products, and individuals must change their behavior. There should be investment in large scale recycling schemes, green infrastructure should have priority when planning new developments and renovating old: All this at a time of population growth and climate change. No one says it will be easy, but it is most certainly possible.

Taking Hard Decisions

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Starting the Conversation

Water is inter-twined with everything we do; energy, food, health and wellbeing, manufacturing are all dependent on its availability. At the very least we need to start a public conversation about its real role in our lives.

¹ Brian D. Richter, David Abell, Emily Bacha, Kate Brauman, Stavros Calos, Alex Cohn, Carlos Disla, Sarah Friedlander O'Brien, David Hodges, Scott Kaiser, Maria Loughran, Christina Mestre, Melissa Reardon, Emma Siegfried. Tapped out: how can cities secure their water future? Water Policy. 2013;(15):335–63

² World Economic Forum 2014

³ Nanotechnology Now. Nanotechnology in Water Treatment. 2012; Available from: http://www.nanotech-now.com/news.cgi?story_id=45894

⁴ National Geographic. Fog Catchers Bring Water to Parched Villages. 2009; Available from: <http://news.nationalgeographic.com/news/2009/07/090709-fog-catchers-peru-water-missions.html>

⁵ OECD. Infrastructure to 2030: Telecom, Land Transport, Water and Electricity. 2006; Available from: http://www.keepeek.com/Digital-AssetManagement/oecd/economics/infrastructure-to-2030_9789264023994-en#page4

⁶ American Society of Civil Engineers. Failure to act: the economic impact of current investment trends in water and wastewater treatment infrastructure. 2011; Available from: http://www.asce.org/uploadedfiles/infrastructure/failure_to_act/asce%20water%20report%20final.pdf



Lead Expert – Michael O'Neill

Certified Environmental Practitioner, Arup
Lead expert on the Future of Water.

Michael is a Certified Environmental Practitioner in Arup's Melbourne office with significant experience in the water and environment sectors working with both the public and private sectors. He has a key passion in ensuring we are fully leveraging the variety of benefits available from well planned and implemented integrated water cycle management projects. Michael has presented at a variety of forums on the importance of a water first approach to urban design and how this approach can fundamentally change the way or urban environments function and feel for the benefit of all.



Lead Expert – Daniel Lambert

Australasia Water Leader, Arup
Lead expert on the Future of Water.

Daniel is Arup's Australasia Water Business Leader based in Sydney. Over his career he has worked on major pipeline, water treatment, wastewater treatment and reuse projects from feasibility stage through to detailed design. Daniel is a strong advocate for taking a holistic approach to urban water management that enables our cities to respond positively to the challenges of climate change and population growth.



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About Future Agenda

Context – Why Foresight?

In an increasingly interconnected, complex and uncertain world, many organisations are looking for a better understanding of how the future may unfold. To do this successfully, many companies, institutions and governments are working to improve their use of strategic foresight in order to anticipate emerging issues and prepare for new opportunities.

Experience shows that change often occurs at the intersection of different disciplines, industries or challenges. This means that views of the future that focus on one sector alone have limited relevance in today's world. In order to have real value, foresight needs to bring together multiple informed and

credible views of emerging change to form a coherent picture of the world ahead. The Future Agenda programme aims to do this by providing a global platform for collective thought and innovation discussions.

Get Involved

To discuss the future agenda programme and potential participation please contact:

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Future Agenda 1.0

The Future Agenda is the world's largest open foresight initiative. It was created in 2009 to bring together views on the future from many leading organizations. Building on expert perspectives that addressed everything from the future of health to the future of money, over 1500 organizations debated the big issues and emerging challenges for the next decade. Sponsored globally by Vodafone Group, this groundbreaking programme looked out ten years to the world in 2020 and connected CEOs and mayors with academics and students across 25 countries. Additional online interaction connected over 50,000 people from more than 145 countries who added their views to the mix. All output from these discussions was shared via the futureagenda.org website.

Future Agenda 2.0

The success of the first Future Agenda Programme stimulated several organizations to ask that it should be repeated. Therefore this second programme is running throughout 2015 looking at key changes in the world by 2025. Following a similar approach to the first project, Future Agenda 2.0 builds on the initial success and adds extra features, such as providing more workshops in more countries to gain an even wider input and enable regional differences to be explored. There is also a specific focus on the next generation including collaborating with educational organizations to engage future leaders. There is a more refined use of social networks to share insights and earlier link-ups with global media organizations to ensure wider engagement on the pivotal topics. In addition, rather than having a single global sponsor, this time multiple hosts are owning specific topics either globally or in their regions of interest. Run as a not for profit project, Future Agenda 2.0 is a major collaboration involving many leading, forward-thinking organisations around the world.

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