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The uphill battle for Singapore's water security is set to continue

With climate change, maintaining and building on the resilience of our water systems will form the next chapter of Singapore's water story.

Shane Snyder

Climate change is an existential threat to Singapore's water supplies and to our water environment. ST PHOTO: LIM YAOHUI

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As I leafed through the Forward Singapore (Forward SG) report and its messages on water resilience, I had a flashback to March 2008, when I received a letter that would forever change my life.

The letter was from Mr Khoo Teng Chye, chief executive of national water agency PUB, inviting me to attend the Water Leaders Summit during the first ever Singapore International Water Week (SIWW).

This "by-invitation only" letter signed in ink intrigued and enticed me to make the long journey to Singapore from the US in June of that year. I will never forget that first taxi ride from Changi to Suntec Convention Centre – indeed, I was instantly in awe of the beauty, cleanliness, and friendliness of Singapore.

I was impressed by what Singapore had accomplished, largely inspired by one of its founding fathers, Mr Lee Kuan Yew. From Newater to Marina Barrage to ocean desalination to imported water, Singapore had already established a brilliant portfolio of diverse sources of water.

Without question, water resilience was core to the success and sustainability of Singapore.

Threats to water resilience

At the most fundamental level, resilience can be interpreted as a secure supply of water. Once the supply is secured, engineered processes can convert nearly any type of water into pure, safe, and reliable supplies for homes and for industry.

However, complacency is the sleeping giant that can disrupt once-resilient water systems, especially with the impact brought by climate change. It is an existential threat to Singapore's water supplies and to our water environment in general.

In 2019, drought across the Malaysian peninsula led to the reservoir level in Johor Bahru behind the Lebam Dam falling to less than 16 per cent. Fortunately, Singapore had three other national taps to rely upon as our imported water reached a critically low point. But prolonged drought in the region will also impact another national tap, our local catchments.

For instance, in February 2014, a severe drought led to extremely dry conditions in both Malaysia and Singapore, whereby Singapore was said to have experienced its driest February since 1869. During a severe drought, Singapore must rely predominantly on desalination to produce the water we all need and enjoy, on top of the water demands from our vibrant industries that drive the country's economy.

In fact, it is estimated by PUB that by 2060, only 30 per cent of the water supply will be needed by homes while 70 per cent will be required by industrial and other non-domestic sector needs. Thus, Singapore will need to secure more water to expand and maintain this rapid non-domestic water demand.

Despite the diverse sources of water we have built over the years, meeting future demand is a huge task that comes with complex challenges.

Saving energy

Seawater is an infinite resource. But the processes to remove the salt from it are generally energy-intensive, around five times more energy than that for the production of Newater in which used water from our homes is collected, treated to very high standards, and then reused by high-tech industries and/or discharged into our freshwater reservoirs.

Singapore has also built large-scale desalination facilities that can treat freshwater, seawater, or even a blend of the two. This system is ideal as it can use far less pressure when urban catchments are full and turn to the ocean during periods of sustained drought.

In addition, my institute, Nanyang Environment and Water Research Institute (Newri), as well as others are working hard to create novel processes that can lower the amount of energy required to desalinate ocean water, but also to increase resource recovery within the brine.

Seawater brine is generally discharged back into the sea, where it rapidly mixes and dilutes. However, this brine has numerous substances of value, such as magnesium, lithium, and others.

While seawater seems to be unlimited in supply, water quality challenges can and do occur that damage the system's ability to function with the possibility of a shutdown.

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Monitoring water quality

Today, Newri experts operate a fleet of drones fitted with hyperspectral cameras that can monitor for algal blooms, turbidity, and other anomalies that may negatively affect the desalination system. By monitoring the sea, we can better prepare for changing water quality or even shut down a facility if a serious issue is detected.

For instance, Singapore is one of the busiest shipping ports in the world and has some of the largest oil refineries in the world, with vast amounts of oil stored in bunkers along its coasts.

For these reasons, Singapore is uniquely prone to oil spills, and since 1960, Singapore and Malaysia together have suffered spills totalling at least 34 tonnes.

In August, an industrial fire near Raffles Marina spilt oil and other chemicals into the sea, killing many fish. These waters are precariously close to PUB's water desalination system intakes near Tuas. Thus, even ocean desalination can be disrupted by human and natural events that change the water quality of the sea.

Likely, Singapore's most daring and famous water success story is Newater.

Detecting anomalies

The Newater treatment system also uses reverse osmosis just as ocean desalination does; however, the lack of high concentrations of salt make the system far less energy-intensive.

Singapore also encourages companies with significant water use to develop their own water reuse systems to reduce the overall water consumption.

One challenge with water reuse is that in an extreme drought or if ocean desalination facilities are disrupted, there must be ample used water supply to recycle. Since Newater begins with what goes down our drains and through our sewer collection system, far greater treatment processes with increased monitoring are required to ensure public safety.

But considering that our sewer network is connected to thousands of homes and industries, it is difficult to know what chemicals are entering the system and whether they will be a challenge to remove using currently available technologies.

This provides another opportunity for innovation, such as sensor systems within the sewer collection network that can detect an anomaly, such as an illegal chemical disposal. Newater also can benefit from the advanced bioassay and analytical capabilities that have been procured and developed at Newri.

Today, there is funding from PUB to develop and deploy these tools in monitoring various water sources to attempt to identify new chemical contaminants as well as assess the toxicity to human cells.

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Beyond homes and businesses

Though all water sources and systems face risks, such as climate change or chemical spills, Singapore continues to innovate to enhance the resilience of our water systems and to maintain utmost safety beyond what is required under regulations.

But our water journey in Singapore extends beyond the water we need and use for our homes and businesses.

The recent Forward SG report makes reference to the PUB's programme Our Coastal Conversation, which had its inaugural meeting in October 2022. During the programme, various participants from diverse backgrounds were unanimous about the need for Singapore to protect its coastal area and community uses areas. They also agreed on the importance of maintaining biodiversity and green spaces along the coastline.

One participant said: "The key thing we want to retain is the beach front, intertidal area, and what this area represents to us. It is part of our psyche of what it means to be a Singaporean as an island nation."

Reading such comments reinforces what I have learnt from the wonderful people I have met on my own, which is that, as an island nation, we must preserve our marine environment for the animals that call it home and for those who use it for recreation.

Indeed, the coast of Singapore provides habitat for many species of fish, phytoplankton, and even marine mammals. I was surprised to learn that among the dolphins and otters are also hawksbill turtles, considered critically endangered by Singapore and by the international community.

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Since we need to discharge our concentrated brine from Newater and because we have a vibrant shipping port along with large refineries and chemical production facilities, keeping guard on our delicate marine systems will continue to be a challenge.

Fortunately, Singapore has what it takes in terms of talent and infrastructure to test and maintain this vibrant ecosystem and remain water-resilient using new technologies, superior education programmes, and through state-of-the-art pollution detection and monitoring systems.

We will have to remain resilient despite every growing threat to our waters, but together, I remain fully confident that Singapore will continue to see safe and reliable water, while at the same time protecting our coasts and recreational waters.

- Shane Snyder is a professor of civil and environmental engineering and the executive director of the Nanyang Environment and Water Research Institute at Nanyang Technological University.