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Rain water is collected through 48 major waterways in 17 interconnected reservoirs. Singapore can enhance freshwater availability by creating large-scale underground water storage facilities. TODAY FILE PHOTO

FINDING WAYS TO STORE MORE RAINWATER AND RECYCLE MORE USED WATER

Making sure Singapore's taps don't run dry

NG HOW YONG

In the past decade, many cities in the world have encountered water scarcity because of uneven rainfall distribution attributed to climate change.

Based on a recent projection by the United Nations, 35 per cent of the world's population will not have adequate safe water to support their basic needs by 2025. It is also envisaged that the shortfall will get worse and the proportion of the world's population that will not have enough safe water will grow to 40 per cent by 2050.

Among the solutions so far are water conservation and finding water from non-conventional sources, such as adopting membrane processes to produce high-quality water for reuse.

Singapore, a city-state on a small island of about 718 km^2 with 5.4 million inhabitants, does not get enough water from natural sources due to limited land space for water storage.

However, with its effective water management strategy and the four national taps — local catchment water, imported water, highly-purified recycled water known as NEWater and desalinated water — Singapore's water needs have been met, even during the dry season.

The four national tap strategy will facilitate Singapore's progress towards water self-sustainability. In 2011, it enabled Singapore to overcome potential shortfalls resulting from the non-renewal of the first water contract with Malaysia.

The PUB now aims to expand the water catchment area to 90 per cent of Singapore's land area, tripling the current NEWater capacity and increasing desalination capacity to respectively meet up to 55 per cent and 25 per cent of future water demand by 2060. This will allow Singapore to be self-sufficient in water should the second water contract with Malaysia not be renewed in 2061.

Without any new water contract with Malaysia, the four national water taps will be reduced to three — local catchment water, NEWater and desalinated water.

Among these three taps, the cost of unit water production is still the highest for desalinated water due to the relatively high energy cost required to desalinate sea water, even with advances in technology.

Therefore, to achieve water self-sufficiency for Singapore at the lowest cost in the long term, maximising freshwater availability from the other two national taps — local catchment and NEWater — is paramount.

IMPROVING WATER STORAGE

Can Singapore adopt other strategies to maximise fresh water from local catchment and water recycling?

In my opinion, there are three possible ways to further enhance freshwater availability: Increasing water storage through an underground storage system, implementing on-site rain-water harvesting, and adopting on-site water recycling.

In Singapore, rain water is collected through 48 major waterways in 17 reservoirs, which are interconnected. By 2060, up to 90 per cent of Singapore land area could serve as a water catchment area.

With an average annual rainfall of 2,357.8mm, up to a maximum of 1,527 out of 1,693 million cubic metres of rainwater (or 4.1 out of 4.6 million cubic metres per day) can be captured annually through the local catchment areas.

An average of 4.6 million cubic metres per day of rain water is theoreti-

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cally more than enough to meet Singapore's current daily water demand of about 1.5 million cubic metres.

However, the lack of sufficient conventional water storage bodies such as reservoirs limits the amount of rainwater that can be stored for producing drinking water.

One of the possible solutions is to create a large-scale underground water storage system at the national level, similar to the Jurong Rock Caverns for oil storage and the concept of future underground cities.

These large-scale underground water storage facilities could be located under parks and canals, below open or multi-storey HDB car parks, under HDB flats and government buildings, and deep under the ground.

These underground storage facilities can be inter-connected and linked to surface reservoirs. They can collect excess rain water from the drainage system or reservoirs. Stored water from the underground water storage facilities can be pumped into surface reservoirs during dry season or directly to water treatment plants to produce drinking water.

In addition, this underground water storage system could also alleviate any potential flash flood in Singapore due to extremely heavy rainfall resulting from climate change, preventing disruption to daily life and damage to property due to flooding.

Besides the large scale underground water storage facilities, rain water harvesting can be implemented for commercial buildings, industrial compounds and private homes.

Relatively smaller underground cisterns can be constructed to store rain water collected from rooftops and private compounds. The stored rain water can then be utilised for gardening and landscape water features or pumped into holding tanks on the top of buildings or houses to be used to flush toilets and for cleaning.

RECYCLING USED WATER

NEWater is also playing a key role as an alternative source of freshwater for Singapore, contributing 30 per cent of Singapore's current water demand and up to 55 per cent of its future water demand by 2060, according to the PUB's plan.

Because of NEWater, Singapore has not experienced any shortage of water supply even during severe dry seasons experienced in recent years.

Moving forward, water recycling through NEWater production will continue to play a pivotal role in ensuring Singapore's water security and sustainable development.

Such water recycling allows "multiplying" of the water supply. When water is being recycled once, as in the case of NEWater, with a recycling rate of 0.5 (i.e., 50 per cent of used water is recycled as NEWater), every drop of used water will produce 0.5 drop of usable water, 0.5 drop of water will produce another 0.25 drop of water, then 0.125 drop, and so on.

Theoretically, one drop of used water will produce another drop of water (i.e., 0.5 + 0.25 +0.125 + 0.0625 +...= 1), which is a multiplier of 2.

If used water such as greywater — wastewater generated in households or office buildings excluding the toilets — can be recycled and used one more time onsite before eventually being discharged to the sewer and recycled as NEWater, the multiplier effect will be further enhanced.

For example, with 50 per cent of used water (greywater) being recycled on-site and 50 per cent of the final used water in the sewer recycled as NEWater, the multiplier will be 3.

Therefore, adopting on-site water recycling is an attractive option. This has been adopted in other countries such as Japan, China, Australia and the United States.

In Japan, on-site water recycling started in the early 1960s, and has expanded rapidly since the 1980s. By 1996, there were about 2,100 buildings with on-site water-recycling systems or connected to large-area water-recycling systems, accounting for 0.8 per cent of Japan's domestic water use.

Implementation of these approaches will not only encourage water technology research development and increase water supply in Singapore, but will also generate economic activities and business opportunities for water utilities companies and local small and medium-sized enterprises, truly establishing Singapore as a "Global Hydrohub".

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