SCIENCE

Science Journals

Nepal rich in water resources, but facing water stress today

Organisations there working with partners including S'pore researchers to tackle woes

Cheryl Tan
In Kathmandu

Nepal, like Singapore, is one of the most water-stressed countries in the world.

But where Singapore lacks access to natural water resources, Nepal has plenty – rivers fed by meltwater from the glaciers in the Himalayas and groundwater aquifers charged by rain.

But as I recently discovered during a trip to Kathmandu, water resources in Nepal are coming under threat from rapid urbanisation, pollution and climate change – issues that also plague many other cities.

The Intergovernmental Panel on Climate Change (IPCC) had in February warned that water shortages, which already plague half the world's population at some point in a year, could become worse due to erratic rainfall patterns or extreme events such as floods or droughts.

Such dry conditions could negatively affect agriculture and energy production from hydroelectric power plants, said the report.

Now, organisations in Nepal are working with various partners, including researchers from Singapore, to help the country safeguard its water resources.

THREATS TO WATER SECURITY

The famed Bagmati River, which runs through Kathmandu Valley, is revered by Hindus and Buddhists as its water is thought to be holy.

Several Hindu temples are located on its banks, and Hindus are cremated on the banks as well.

But the state of the river now is far cry from what it was in the 1970s.

A visit to the river earlier this month reveals stagnant, murky brown water instead, chock-full of litter like plastic waste and bits of cloth.

The cause of the pollution?

Concrete, carpet and other industries are dumping their waste in the river, with households doing the same with their sewage, said freelance climate change and senior watershed expert Madhukar Upadhya.

Recounted the 44-year-old: "Back then, there were no rules governing waste disposal and people thought we had enough water, so we could just wash everything away – which was true back then, as the population was not as large."

Mr Upadhya, who used to do his laundry and take baths in the river, said that as Kathmandu Valley did not have a good municipal water supply back in the 1960s and 1970s, the river was an important part of people's lives.

The 1990s heralded the age of rapid urbanisation in Nepal, but it was not until 2015 that rules forbidding the dumping of solid and industrial waste were introduced.

Even then, this was largely ignored. Stricter rules now are helping to change people's mindsets, said Mr Upadhya, who still lives in Kathmandu.

River sampling efforts by the Nanyang Technological University's Nanyang Environment and Water Research Institute (Newri) have found that in certain sections of the river, the water is highly toxic to human cells, and that there is an unusual amount of pharmaceutical discharge, including antibiotics, which could lead to antibiotic resistance, said its senior director Shane Snyder.

But the source of this pharmaceutical discharge remains unknown, he noted.

Mr Upadhya said: "The problem that the Bagmati River in Gatuig is that it has lost its ability to flush out these pollutants and clean itself naturally."

For one, the Bagmati River now has a decreasing gradient.

This refers to the parcel of land that channels rainwater (or groundwater) beneath the earth's surface, which in turn feeds rivers like the Bagmati. "The greater the amount of rainwater that is stored as groundwater, the richer the watershed becomes, because it can continue to feed rivers like the Bagmati during the drier seasons," said Mr Upadhya.

However, rapid urbanisation in the valley has seen 40 per cent of the valley floor being sealed by roads and buildings in the past 40 years, which makes it impossible for rainwater to seep into the ground, he added.

"Many traditional ponds that collected rainwater and contributed to groundwater recharge have also been lost to other structures due to unplanned urbanisation," he said.

At the same time, the amount of rain falling over Nepal is also becoming increasingly erratic due to climate change.

Climate change expert Raju Pandit Chhetri, executive director of Prakriti Resources Centre, a non-governmental organisation working on sustainable development and environmental justice in Nepal, said that rainfall during the monsoon season is becoming more erratic.

The season usually begins in the first week of June and lasts for around three months, till early September.

"What's happening nowadays is that you often get a very heavy downpour in a single day, but dry weather during the rest of the week," said Mr Chhetri. This is opposed to rainfall being more consistently spread out over the week.

PLAGUED BY POLLUTION

The problem that the Bagmati River is facing is that it has lost its ability to flush out these pollutants and clean itself naturally.

MR MADHUKAR UPADHYA, a freelance climate change and senior watershed expert, on the famed river

ERRATIC RAINFALL PATTERNS

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MR RAJU PANDIT CHHETRI, executive director of Prakriti Resources Centre, on how rainfall during the monsoon season is becoming more erratic

Another IPCC report published in August last year warned that the water cycle has been intensifying and will continue to do so as the planet warms.

This means more wet and dry extremes that will increase with future warming.

Heavy rainfall could also have more disastrous effects, such as crop losses for farmers and landslides and flooding in various areas around the country.

And while there is a shortfall of rain during some periods, too much rain at other times has also led to disastrous consequences.

SOLUTIONS

Singapore has been able to overcome its water scarcity through building expensive infrastructure, such as used-water treatment plants and desalination facilities that purify seawater.

But experts say such interventions may not be as suitable for Nepal, especially if those are not adapted to climate change.

For instance, the Melamchi Water Supply Project, an initiative of the Nepalese government that took over two decades to build, was designed to divert about 170 million litres of fresh water daily from the Melamchi River through a 26km tunnel to Kathmandu. This accounted for less than half of Kathmandu's daily water demand.

But unexpectedly heavy rainfall followed by a landslide caused significant damage to the tunnel on June 15 last year, just months after it began operations.

The tunnel was also closed this year ahead of the monsoon season to prevent a similar occurrence.

The project, worth 25 billion Nepali rupees ($$308 million) now faces a lot of uncertainty, including being not well adapted to the changing climate, said Mr Upadhya.

"Now, with there being more extreme weather events occurring due to climate change, we don't know what the future will hold for this project, and whether it is still viable in the long term," he added.

Instead, Mr Upadhya proposes simple, small-scale solutions that work in closely with nature as possible.

For instance, creating small ponds by tapping rainwater in certain areas of the watershed can allow water to re-enter the earth, and recharge groundwater reserves.

This has been trialled by the International Centre for Integrated Mountain Development in several villages in Kavre – a district east of Kathmandu – after an earthquake there caused some springs to run dry.

In Nawalparasi district in the southern lowlands of Nepal, Singapore's Newri team partnered local organisations there to install water filtration systems in two secondary schools, which helped remove arsenic from drinking water.

More importantly, Mr Upadhya hopes for more to be done to conserve and restore the rivers and tributaries in the Kathmandu Valley, so that they do not suffer the same fate as the Bagmati.

"We still need our rivers and to tap our own groundwater resources to keep us alive. And if all that is gone, then where do we get our water from?" he said.

"When responding to climate change and our rapidly depleting resources, our approach tends to often be short-term and political in nature, involving large projects which fail to recognise the way in which different natural resources are linked and the complex processes involved.

"This can be expensive, and could inadvertently lead to maladaptation."

He added: "More long-term solutions and climate adaptation options must be considered for us to safeguard our water security."

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Former farmer Ramprasad Yadav's left foot had to be amputated after years of arsenic poisoning from the water he had been drinking in Nawalparasi district in Nepal's southern Terai region, a lowland area. 17 PHOTOS: DEBORAH TOO

Left: The Pashupatinath Temple, a Unesco World Heritage site in Kathmandu, on the banks of the highly polluted Bagmati River.

Above: A cremation ceremony taking place at the temple by the water's edge. The famed river which runs through Kathmandu Valley is revered by Hindus and Buddhists as its water is thought to be holy.

Right: Children at a popular stone water spout in Patan. Such spouts are part of an ancient water distribution system that uses gravity to channel rainwater to residents in Kathmandu Valley.

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How NTU is helping schools in Nepal to battle arsenic contamination

Cheryl Tan
In Nawalparasi (Nepal)

When Mr Ramprasad Yadav, who lives in rural Nepal, started developing skin lesions on his body some 17 years ago, he did not think much of the little pigmented spots.

But they were a tell-tale sign of arsenic poisoning – a condition which would become so severe that it turned his left foot gangrenous a few years later, leading to eventual amputation.

This was all because of the water that he had been drinking.

The lowland area Mr Yadav, 59, lives in – Nawalparasi district in Nepal's southern Terai region – has always been an arsenic hot spot.

Arsenic contamination is very much like "slow poison", said Dr Makhan Maharjan, a programme director of non-profit organisation Health and Environment Development, Nepal (Head-Nepal). He has spent more than 20 years working on arsenic-related projects in the area.

"For such chronic contamination, at the early stages, there are no symptoms, but prolonged exposure at high concentrations has far-reaching effects," he added.

"Arsenic is naturally found in rock and mineral formations; and as the water has been travelling from the Himalayan mountains to the lowlands over thousands of years, its layers of sand deposits are now rich in arsenic. This is where people are now extracting their water from," said Dr Maharjan.

Those living in the Nawalparasi area have been drawing from shallow aquifers, or rock formations underground, through the use of hand pumps. This is where the arsenic content tends to be elevated.

Now, a team from Singapore's Nanyang Technological University (NTU) is providing a solution. Dr Maharjan has been working with scientists from its Nanyang Environment and Water Research Institute (Newri) to install water filtration systems in schools in Nepal.

As part of a collaboration between Newri's philanthropic arm NewCommon and Head-Nepal, the first drinking water facility was installed at Saraswati Secondary School in 2020.

The project is supported by Lion Foundation Fellowship, a non-profit programme which empowers academics from Asean, South Asia and Central Asia to tackle water and sanitation problems in their home countries.

A second pump was commissioned in end 2020 at Shree Janta Secondary School, which is in the same district.

The completed water filtration system was officially handed over to the school management on June 15, at a ceremony attended by NTU and Head-Nepal representatives. This project will benefit more than 600 students and teachers – more than double the number in the original project.

The system, which works primarily by leveraging the ability of iron nails to attract and absorb arsenic particles, is able to make the water clean by filtering about 65 to 95 per cent of arsenic in it.

Dr Maharjan, who was in charge of both projects, hopes the children and youth benefiting from these taps can become important environmental champions and change-makers.

"If we reach them, educate them in school about arsenic contamination and its health concerns, they can take this message back home and educate their families and their larger communities," he added.

But the task of getting clean water to everyone is a difficult one.

When 17-year-old Sandip Yadav from Saraswati Secondary School learnt about arsenic contamination, he felt compelled to convince his father to get a similar filter. But this was not a simple purchase for the family.

"My father, who is a labourer, had to save up for several months, and eventually we were able to purchase the water filter which cost about 6,500 Nepali rupees (S$72.50). I feel more relieved knowing that the water we consume is now safer to drink," he said.

Many others are unable to afford similar filters, and are still relying on untreated, contaminated water.

Ms Sunjhana Chaudhary, deputy mayor of Rangman Municipality in Nawalparasi, said foreign aid will be key if the district is to build piped water systems to serve households, as well as install more water filtration systems in public places.

Apart from NTU, there have been other institutions and non-governmental organisations (NGOs) in the region offering help.

For instance, some NGOs have provided household-level arsenic removal filters to Mr Yadav's village, and a deep tube well system was installed about two years ago, said Dr Maharjan.

Unlike the hand pumps, these deeper tube well systems – which are a lot costlier – can extract water from deeper aquifers underground which have cleaner water that is arsenic-free, he added.

Mr Yadav and his four children, who also suffered from arsenic poisoning in the past, now have access to clean water.

"Still, I worry a lot about their future. I hope clean water for them is here to stay," he said.

AFATHER'S CONCERN

Still, I worry a lot about their future. I hope clean water for them is here to stay.

MR RAMPRASAD YADAV, on his four children, who also suffered from arsenic poisoning in the past but now have access to clean water

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Right: Students of Saraswati Secondary School drinking safely from a pure drinking water point. The school got a water filtration system with help from the philanthropic arm of NTU's Nanyang Environment and Water Research Institute (Newri).

For right: Students at the Shree Janta Secondary School, which also got a water filtration system. Here, a student is using one of the old water hand pumps, which can now be used only for washing due to arsenic contamination.

Dr Makhan Maharjan, a programme director of non-profit organisation Health and Environment Development, Nepal (Head-Nepal) and a research assistant collecting samples near the Pashupatinath Temple to assess the physical and chemical characteristics, and the microbiological quality of the Bagmati River water.