Restore Our Earth

Volume I

Rejuvenating Water

EARTHDAY.ORG

22 March, 2021

Dear Reader,

Earth Day Network® (doing business as EARTHDAY.ORG™) grew out of the first Earth Day on 22 April, 1970. This pivotal moment in history united people globally with the single-minded objective of ensuring a greener, cleaner planet for all; one in which natural wealth increases and waste is managed. Fifty years on, the organisation is recognised as a central actor in the worldwide fight against climate change with engagements in 190 countries with over 50,000 organisations.

Our ongoing global theme is 'Restore Our Earth'. It directs attention to the need to refresh aquifers, rejuvenate the soil, regrow green cover, manage waste, protect species and other natural wealth, and ensure favourable Air Quality Indices, amongst others.

This ebook focuses on the very precious natural resource—water.

Of all the water that exists on our planet, around 97% is salt water. Of the 3% or so of fresh water available, almost half of it remains frozen in glaciers, ice caps, or deep underground aquifers. Yes, just around 1.5% is available for our use, making every drop count. Keeping in mind that the population is expanding, resulting in more people to share this minuscule resource, it is estimated that by 2025 1.8 billion people will live in areas impacted by water scarcity.

We hope you enjoy reading the case studies that expound some of the innovative strategies adopted in India to help conserve, manage, purify and distribute water. Read about efforts to reduce wastage, make judicious use of every droplet, adopt means to purify contaminated water, and recover it from sewage.

We are very grateful to all those who sent in material for the ebook and our India team, which worked tirelessly to put this volume together. Our heartfelt thanks to Wysiwyg Communications for the beautiful designing.

Regards,

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Introductory Note

According to a World Bank Report* India is home to 18% of the Earth's population but only 4% of its water resources. Referring to India, the report states, 'Its per capita water availability is around 1,100 m^3, well below the internationally recognised water stress threshold of 1,700 m^3 per person, and dangerously close to the water scarcity threshold of 1,000 m^3 per person.' The report also notes that: 'Population growth and economic development put further pressure on water resources. Climate change is expected to increase variability and bring more extreme weather events.' While less water per person is a problem, it is compounded by wastage and contamination in some cases—a grim scenario, indeed.

Our ebook shares 25 ways to make judicious use of water, increase its capacity and ensure its purity. It showcases both Do It Yourself methods as well as those by experts that have been successfully implemented by individuals and organisations around the country.

Read about the Taraltec® Reactors retrofitted into hand pumps, resulting in a 99% plus reduction of microbes in water through biomimicry inspired by the snapping shrimp. Earthfokus valves convert water to mist and help save 50–60 litres of water per faucet per day. Technology developed by WaterMaker (India) Pvt. Ltd. draws in air and converts it into water safe for drinking. Read about ways the Shri Mata Vaishno Devi Shrine Board saved millions of litres of water by installing 'Flush Me Not' urinals. While indigenously growing phragmites help purify wastewater in Himachal Pradesh, Absolute Water Pvt. Ltd. has set up 100% green water recovery plants to convert sewage into drinking water.

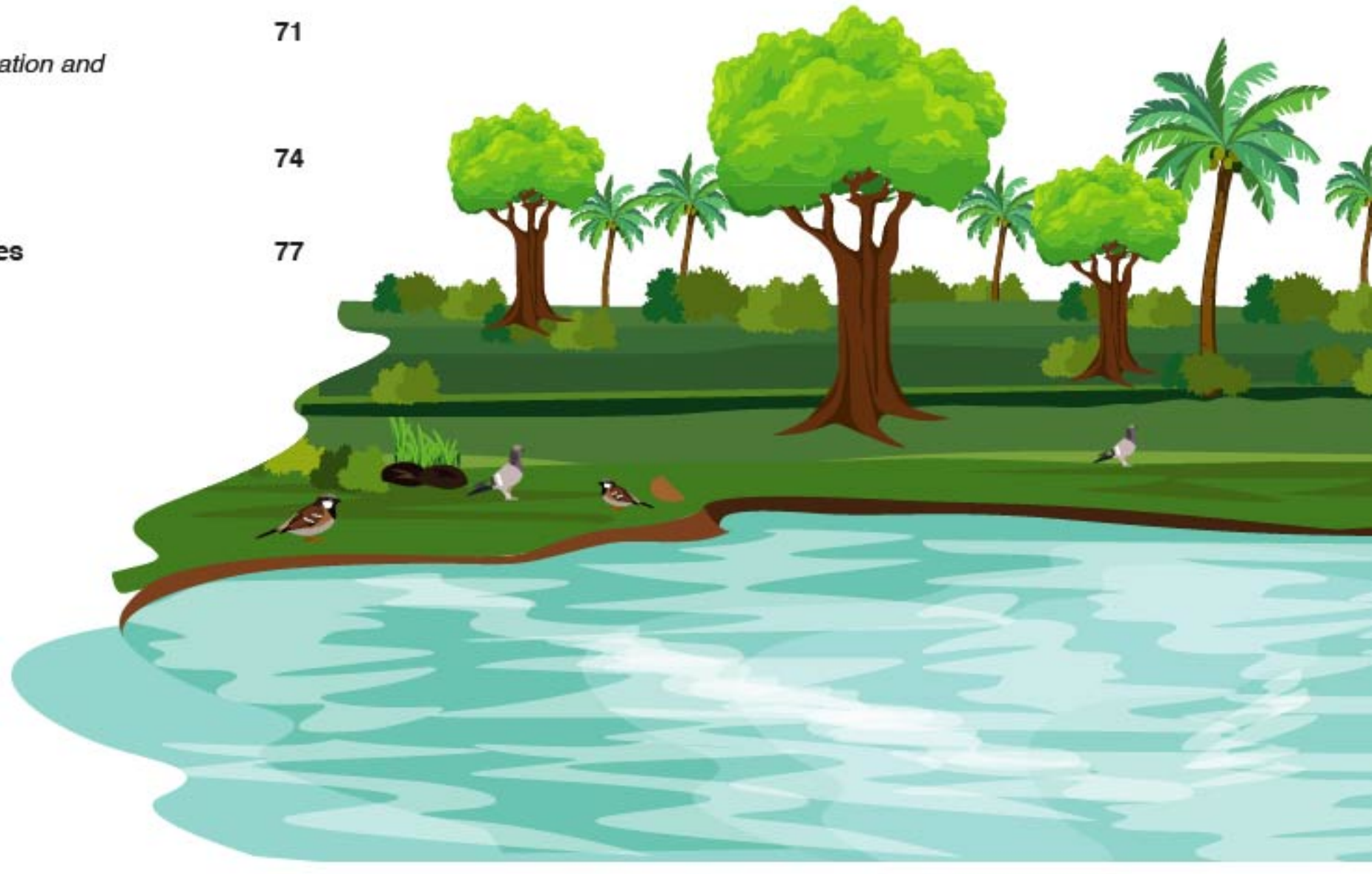
There are accounts of runoffs conserved by *Chaukas* in Rajasthan and water put to multiple uses by the traditional *Zabo* system in the hills of Nagaland. Read about the amazing use of gravity to form ice stupas in Ladakh. These store several litres of frozen water in autumn for agricultural use in the spring. Mountain spring waters, a lifeline for many hill people, are revitalised by Sikkim government's *Dhara Vikas* initiative. Read about ways pure water is made available by the revival of ancient *Surangas* (tunnels) and *Kenis* (shallow wells) in Kerala. A tribal area in Jharkhand recycles discarded bags to build low-cost dams. In Assam, Arsiron Nilogon proves to be an efficient method for laypersons to remove arsenic, iron and other heavy metal contaminants from groundwater. Neela Hauz in Delhi is given new life through the construction of wetlands to become a verdant oasis in the bustling capital city, one that now attracts hundreds of birds. In Indore's Nalanda Sarovar, Clean Water has placed artificial islands that help keep the waterbody clean.

Often, it takes just a small group, or even just one person, to purify or save vast quantities of water. Read how youths in West Bengal spend their Sundays fixing the wastage of water from broken roadside faucets. In Bengaluru, the question 'Why Waste?' led a young girl to discourage the practice of filling customers' glasses to the brim at eateries. Her movement, 'Glass Half Full', has helped save precious amounts of water, both in India and overseas. Read about the young girl from Odisha who won a Google Science Fair award in 2015 for the method she developed to use discarded corn cobs to filter water.

The way communities unite to make areas of the Thar Desert in Rajasthan water-sufficient is an example to emulate. In Uttar Pradesh, the efforts of the villagers of Antwada have successfully resurrected the Kali River—no mean feat! Keeping in mind the heavy dependence of agriculture on water, we give you Valoric Venture's system that significantly minimises water evaporation when used in fields; as well as Kheyti's greenhouses, which lower the water requirement of farms in Andhra Pradesh by an astounding 90%. Also included are ways various artistic genres utilise innovative means to draw attention to the importance of water, as for example through the dance performances Sparsh Ganga organises, or the unique concept of visualising water narratives by the Living Waters Museum.

These are just some initiatives that focus on water. Their combined efforts help increase water availability to millions by capturing each drop, storing it safely, reducing its wastage, using it judiciously, purifying what is contaminated, as well as recovering it from wastewater. Our role is to widen people's awareness about such efforts so that many more can benefit. Should you know of other notable examples, please do share them with us. Let's all unite to help 'Restore Our Earth'.

*https://www.worldbank.org/en/news/feature/2019/12/09/solving-water-management-crisis-india



Accelerating the Revival of Springs

Accelerating the Revival of Springs

Do you recall stopping your car on a winding road in hilly terrain to taste the refreshing water from a spring? As per the last estimate, there are five million springs in India, of which nearly three million are in the Indian Himalayan region. This area spans ten Indian states, four hill districts and is home to over 50 million people. Local populations refer to this natural phenomenon by different names—*dhara*, *mool*, *kuan* and *chashmanaul*—but what's in a name? Call it what you may, the point is that free-flowing spring water is a lifeline for them. It is their fundamental source of water for domestic use, cattle-rearing and agricultural needs. Wildlife also drinks from these natural fountains.

Over the past century, there has been a rapid decline in springs supplying mountain-fresh water. Erratic rainfall patterns, seismic activity, deforestation and changing land-use patterns from agricultural to infrastructural needs, have significantly impacted these mountain aquifers, resulting in reduced volumes of water in the once gurgling springs. When a nearby spring starts dying, it is the rural women who suffer the most. With their hands already full collecting firewood, providing fodder for cattle and other domestic chores, they then have the additional burden of fetching water from sources farther from their homes.

The state of Sikkim comprises the Eastern Himalayan Range. As in other regions, the adverse effect of climate change on rainfall threatens the delicate, holistic balance that once stimulated its ecosystem. Furthermore, as the terrain is mountainous, only about 15% of rainwater percolates into the soil. The impact of this change on the lives of the Sikkimese people gained wide attention during a seminar organised by the World Wildlife Fund (WWF) in 2008, when a group of local women spoke of the daily drudgery they have to suffer because of lack of water.

Recognising this need, the Rural and Development Department (RDD) of the Government of Sikkim conceptualised the *Dhara Vikas* initiative to revive the state's dying lakes, springs and streams. The initiative aims to ensure water security by breaking the cycle of abundance and scarcity. It also seeks to enhance the hydrological contribution of the mountainous ecosystem as a water tower for the people, ensuring disaster risk management by reducing landslides and floods. It is supported by the central government sponsored Mahatma Gandhi National Rural Employment Guarantee Act scheme, with technical support from other government agencies as well as organisations such as WWF-India; People's Science Institute, Dehradun; the Advanced Centre for Water Resources Development and Management, Pune; and Arghyam, Bengaluru.

Implementation of the *Dhara Vikas* initiative focussed on executing a scientifically robust strategy and on generating awareness. Awareness generation has been an important part of *Dhara Vikas*. Micro-level planning involves discussions with the local populace. All work-related resolutions are taken up in the *Panchayats* and decided upon at the village level. Capacity-building measures include programmes organised in coordination with various NGO stakeholders to develop specialised knowledge and skills in areas such as rainwater harvesting, geohydrology (the science that deals with the character, source and mode of occurrence of underground water) and spring discharge measurement. Global Positioning System (GPS) tagging and laying of staggered contour trenches and ponds also helps. The RDD identifies the recharge areas of various springs and streams based on hydrogeological assessments, in order to control runoffs and increase permeation to enhance groundwater recharge.

According to the RDD, *Dhara Vikas* has significantly helped recharge lakes and revive several springs in Sikkim. As many as 70 are now revived. Most of them are in Kaluk, Ravangla, Sumbuk, Jorethang and Namthang. Further, three dried-up lakes, Dolling, Datum and Karthok are revived to their natural states. Other lakes, such as Nagi and Tamle Pokhari, have been converted into recharge structures. The RDD is working on two dried-up lakes in West Sikkim, Resum and Suke Pokhari, to revive them as well. It has also led to the reforestation of seven hilltop forests at Simkharka, Sadam, Tendong, Maenam, Gerethang, Chakung and Sudunglakha. With the revival of lakes and springs and the increased awareness, villagers in the area have started constructing water storage tanks. They use the day-time discharge from springs for irrigation, while the night-time discharge is used in rotation to fill personal tanks.

Another significant impact of the initiative was the creation of the village spring atlas web portal, which provides information on more than 1,500 springs and can be accessed at https://www.sikkim-springs.gov.in/. Increased irrigation has encouraged farmers to cultivate new crops such as beans, radish, cauliflower, cabbage and chillies, along with paddy and tomatoes. Many perennial garden fruits, such as guavas, bananas, oranges and litchis, are now cultivated.

As this initiative involved the implementation of a new concept, many lessons were learnt along the way. These include the fact that Sikkim's Himalayas may not have a confined aquifer system for individual springs. It was noted that the spring-based approach did not significantly result in improving spring discharges. Consequently, a hill-landscape approach was used. This took into consideration all the springs abutting the entire hill or the extent of the hill range. To recharge the aquifer, it was assumed these springs were interconnected as a network of cracks and fractures developed over Sikkim's metamorphic areas. The recharge area in the former approach, which was 2–3 hectares, has now increased to more than 20 hectares through the latter one. Trenches for groundwater recharging were initially dug without adherence to geohydrological requirements. Some trenches were dug on terraced fields instead of on sloping land, while others were dug without supervision, to ensure maximum trapping of surface runoffs, thus making them ineffective.

Similarly, many horticulture and forestry activities, initially undertaken to improve groundwater recharging, did not show any positive outcomes. In time, it was realised that trenches and ponds had a more significant impact on groundwater recharging and soil moisture than plantations, which lose moisture through evaporation. In certain locations, the lean period discharge was not recorded, making any conclusive impact assessment impossible. all these issues are being addressed.

The *Dhara Vikas* initiative has enabled about 900 million litres of annual groundwater recharge. It is recognised with several awards, including the Prime Minister's Award for Excellence in Public Administration (2011–2012); the Skoch Gold Award; and the National Groundwater Augmentation Award (2010–2011) to WWF-India for technical support, amongst others.

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Arsiron Nilogon

Arsiron Nilogon

Arsenic is a deadly poisonous water contaminant. It is difficult to detect as it is colourless, odourless and has no sedimentation. It is present in groundwater in certain parts of the world, including Assam. The contaminant affects enzymes that control many biological processes in the human body. The intake of untreated water laced with arsenic can over time lead to chronic poisoning and diseases such as skin problems, bronchitis, diabetes, bone marrow depression and cardiovascular disorders. Arsenic is known to be carcinogenic—it can cause cancer in tissues and organs when ingested repeatedly.

While it is advisable to remove all arsenic from drinking water, the WHO sets a maximum permissible level of 10 ppb (10 micrograms per litre). In many districts of the Brahmaputra and Barak river valleys of Assam, groundwater is found contaminated with arsenic far above this level. For the rural populations, arsenic removal techniques such as ion-exchange, Reverse Osmosis, ultrafiltration, and adsorption are unsuitable because of their high costs, the requirement of power, and the limited facilities available for disposal of the large quantities of sludge produced.

In the Chemical Sciences Department of Tezpur University's laboratories in Assam, Professor Robin Kumar Dutta and his students developed an efficient, Do-It-Yourself, low-cost method to remove arsenic, iron and other heavy metal contaminants from groundwater. He says that his research's biggest motivator was great personal loss: he lost his father, brother, uncles and a friend to cancer. Testing the water in his river island village, Majuli, confirmed arsenic presence to be far above permissible limits!

Professor Dutta named the method he developed 'Arsiron Nilogon' as this removes both arsenic and iron simultaneously. In Assamese, 'Arsiron' stands for arsenic and iron, and 'Nilogon,' removal. Arsiron Nilogon removes arsenic from groundwater from any initial concentration to less than 2 ppb or undetectable levels for any water quantity, be it 20 litres or 200,000 litres. The method is simple and easy to assemble at home by a layperson. It is useful for both household and community purposes. The simplicity of the Arsiron Nilogon process doesn't take away from its efficiency. This enabled Professor Dutta to easily transfer the technique from his sophisticated laboratory to the populace.

Arsiron Nilogon is based on oxidation coagulation-adsorption at optimised pH. There is no requirement for any energy to operate it. All it needs is just two buckets that act as filters. These are fitted with taps at different levels. The water is treated with small quantities of common and safe chemicals: cooking soda ($NaHCO_3$), potassium permanganate ($KMnO_4$), and ferric chloride ($FeCl_3$). These help in various ways to remove arsenic and iron. The doses of chemicals in the method differ and depend on whether iron is also present in the water along with the arsenic. The cooking soda controls the water's pH to render it to optimum conditions for the precipitation of iron, should this also be present. At lower pH, iron precipitation is slow, whereas at higher pH, some soluble iron remains in the water. Potassium permanganate oxidises difficult-to-remove arsenite ions to easy-to-remove arsenate ions. This popular oxidising agent for water treatment use has other advantages over its competitors: it exists as a stable solid with high water solubility and forms highly insoluble manganese dioxide at mild alkaline conditions, leaving no manganese or any other residue in the treated water. The manganese dioxide speeds up otherwise very slow arsenite to arsenate conversion and absorbs arsenate ions from water. The mild disinfectant potassium permanganate kills the bacteria present in the water. Ferric chloride is more efficient than alum as a coagulant. It leaves no residual toxic substance in the water, unlike alum, which leaves aluminum ions suspected of causing Alzheimer's disease. The coagulates absorb and remove arsenic

sufficiently in the mild alkaline pH range provided by cooking soda. As long as the filter's cleanliness is maintained, no further disinfection of the water treated by Arsiron Nilogon is needed, since potassium permanganate itself is a mild disinfectant.

For household use, it is recommended that if iron is present, it is removed first by sand-gravel filtration. This gives better results and reduces costs. The water is now usable for domestic purposes other than drinking, cooking, and washing items to be cooked such as vegetables, rice, pulses, fish, meat, etc. Once all the arsenic is removed by Arsiron Nilogon, the water is safe to drink.

The recurring cost of the chemicals used in Arsiron Nilogon is approximately 50 paise per litre of water, ₹50 per 100 litres, or ₹500 per 100,000 litres. The tiny quantity of solid sludge produced passes the toxicity characteristic leaching procedure test of the US Environmental Protection Agency for dumping in landfills. In fact, the leaching of arsenic from the solid sludge of the Arsiron Nilogon method is around 1/500 lower than the Agency's recommended limit.

Presently in Assam, there are around 5,000 household and small community-used Arsiron Nilogon filters with capacities ranging from 20 to 500 litres. These benefit thousands of people. Some schools have the students put together Arsiron Nilogon as a Science Project and allow them to take home the filters assembled. The Sarva Siksha Abhiyan Mission in Assam (with 4,450 schools under it) has instructed all schools to implement Arsiron Nilogon across affected areas. The process to do so has begun. What is wonderful is that hundreds of trained volunteers help implement Arsiron Nilogon in villages across Assam, often with the support of NGOs and with funding from corporates.

Arsiron Nilogon's success has reached far and wide and talks are underway to extend its use to other states.

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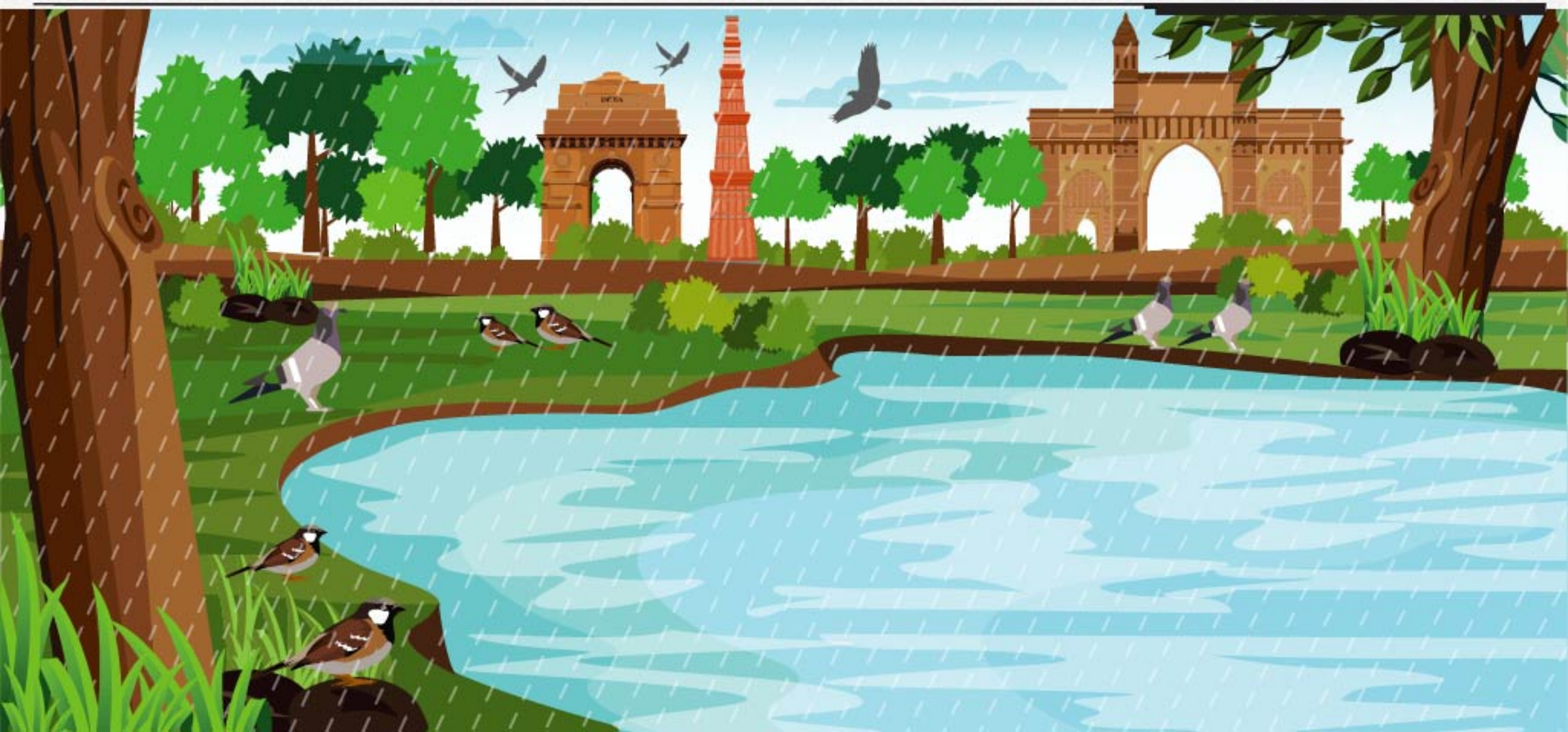
Constructed Wetlands



Constructed Wetlands

Neela (blue) Hauz (lake) is a natural basin amidst the bustling city of Delhi. It once received the entire drainage from the surrounding Aravalli Hills and the Sanjay Van (forest). Years ago, when the lake spread over 7 hectares, it was a source of drinking water for the city. Over the years, Neela Hauz reduced to half its size. Parts of it were drained off to construct a road; others were filled with the indiscriminate dumping of construction and other debris. Further, its water carrying capacity was impaired by the growing sedimentation in the lake. This resulted from the reduced intake of freshwater as infrastructure that had sprung up around the lake blocked channels of ingress.

Not surprising, the result was in reality, a 'dead' lake. Overrun by water hyacinths, there was just a small patch to suggest a flicker of life in this otherwise comatose natural body. Even that was filled with sewage (not water) from which a stench emanated. Worrying statistics characterised the sewage water: 40–80 mg/l BOD (Biological Oxygen Demand); 80–200 mg/l COD (Chemical Oxygen Demand); and 0 mg/l DO (Dissolved Oxygen). Other pollutants were found in concentrations higher than permissible limits. A deplorable state of affairs, indeed.

In 2010, residents of the Jawaharlal Nehru University and other neighbourhood colonies formed the Neela Hauz Citizens Group. They filed a Public Interest Litigation petition against the government, demanding that the lake be restored to its erstwhile glory. With a favourable judgment in hand, hope sparked. The Delhi Development Authority, directed to take cognisance of the matter, began desilting the water body to depths varying from 1 metre to 5 metres. The removed silt was used to build embankments and landscape the edges of the lake. To attract rain, some 20,000 saplings of 35 species of native trees of six biological communities were planted. The authorities engaged the Centre for Environment Management of Degraded Ecosystems (CEMDE) of the University of Delhi to develop the lake's area into the Neela Hauz Biodiversity Park. The CEMDE has set up a constructed wetlands system for in-situ biological remediation of the raw sewage (the only water source) entering the lake.

A constructed wetland is an artificial system of natural vegetation, soil and organisms to treat wastewater. It is an alternative to conventional technologies for wastewater treatment. The one in operation at the Neela Hauz is a horizontal surface, free-flowing type that comprises two oxidation/stabilising ponds, a physical filtration unit, and constructed wetlands with ridges and furrows. The furrows harbour 25 species of rooted and submerged floating plants with billions of microbes in rhizosphere sediment. These can biodegrade even detergents and emergent pollutants and have trophic structures that reduce coliform density. Typha, Phragmites, Ipomoea, Alternanthera and Polygonum are some of the plants used. The filtration unit has ridges made of boulders with large pores as well as stones and pebbles with smaller pores. All the different sized pores generate turbulence when the sewage passes through them. This results in high levels of oxygen saturation that leads to enhanced biodegradation of organic pollutants.

Within three years of the work beginning, success was visible. The constructed wetland now converts one million litres of sewage into clean water daily to feed Neela Hauz. The quality of the water is comparable to river water, with a BOD lower than 4 mg/l. This result is achieved within 24 hours and requires zero energy. Saplings planted have developed canopies and are as tall as 15–20 ft. Increased vegetation

attracts hundreds of migratory birds and many resident ones as well. It is now a revived ecospace. Flora filters the air in the scented garden and the butterfly corner. The scenic landscape has become a popular spot for visitors, many of whom frequent it to breathe the fresh air, soothe their eyes with the sight of freshwater and marvel at this bounty of nature amidst a busy urban space.

Professor Babu, the person spearheading the Neela Hauz's resurrection has caught the attention of leading global organisations, planners and policymakers who are working with, or considering setting up similar wetland models. He attributes his success to the support of his colleagues Nidhi Seth, Yasir Arafat and Vikrant Goswami.

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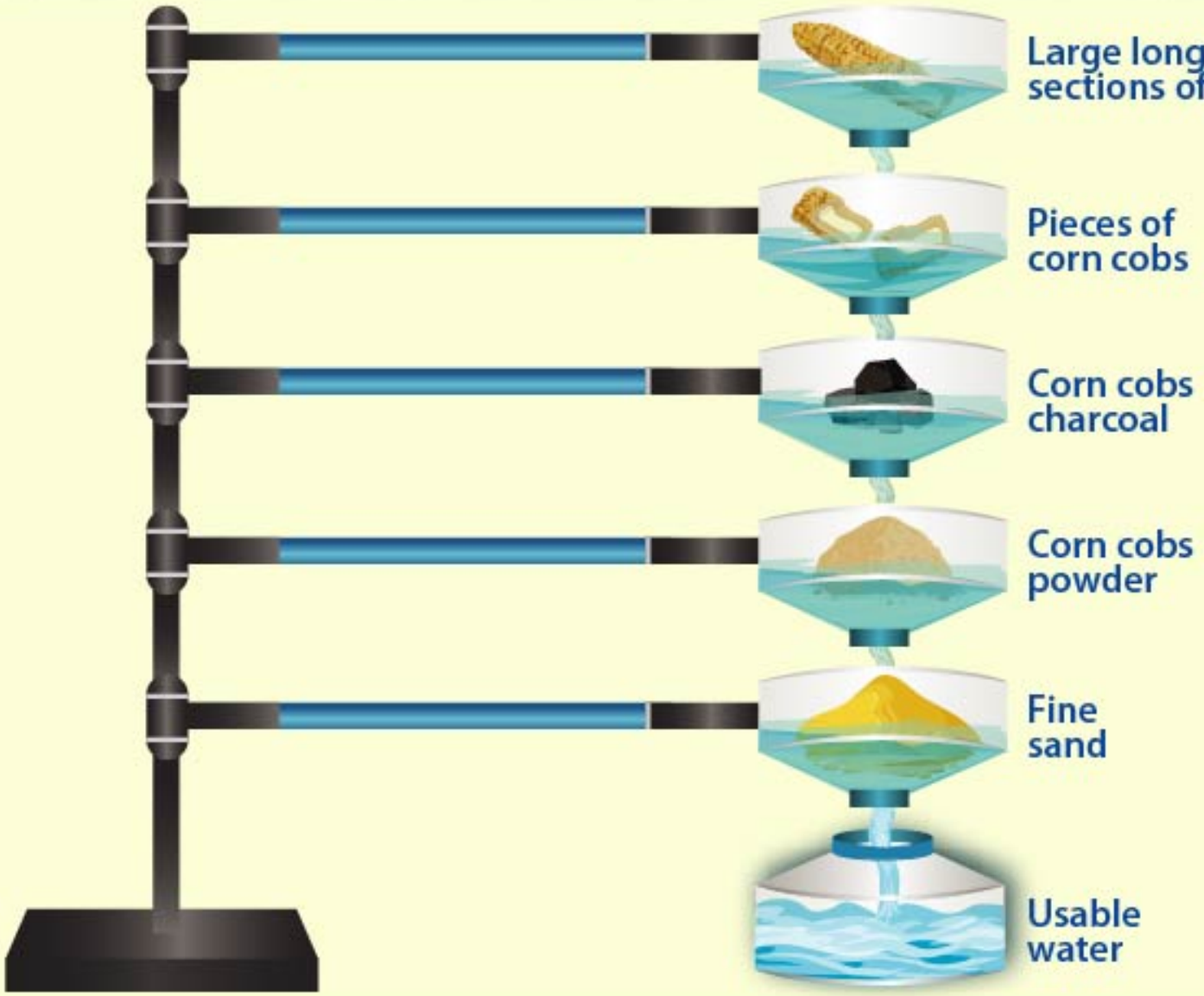
Discards that Filter



Discards that Filter

The need to purify water is something people have endeavoured to achieve since time immemorial. Lalita Prasida, a student at Delhi Public School in Damanjodi (a tribal area of Odisha), dreamt of her name being glorified as the one who found an easy method to render impure water fit for use. Her parents spoke about how things had changed since they were children. Then, there was plentiful and fresh water for everyone. But now?

They say 'little girls with dreams become women of vision'.
That is so apt for Lalita. Working in her school's chemistry laboratory, she found an ingenious way to use agricultural waste to purify water! Any guesses which discard she put to use?

Lalita first shortlisted crops from which we amass the largest quantity of natural waste. The obvious winners are popular staples that are part of the daily sustenance of millions of Indians. She found that the chaff from the two principal ones (rice and wheat) are easily degraded in 4–8 weeks and can even be used as cattle fodder. However, waste from another major staple, maize (*Zea mays*, better known as corn), has problems. It takes 18 years for a corn cob to decompose in a landfill. Unfortunately, it is also useless as animal feed because it is deterimental to their alimentary canals. Yet, the pores on corn cobs are incredibly absorbent, making waste corn cobs ideal to draw out contaminants such as salts, detergents, floating particles, dyes and even a few heavy metals.

The initial experiment was with a single corn cob. Lalita first made a hole in its pith, poured domestic sewage water into it and kept it aside for a day's observation. To her surprise, she found clear water had collected in the bottom vessel. Even more impressive was the fact that upon testing the sample, no impurities were found in it. It was fit for use for all purposes except direct consumption, for which it needed to be first boiled. Lalita conducted the next trial with 7–8 cobs. These she placed in a bucket of sewage water and left overnight. This experiment also showed excellent results.

With support from her teacher, Lalita now moved to implement the idea on a larger scale. Corn cobs were procured from farms and dried in the sun. Next, keeping in mind the efficacy of the five-layer stepwise filtration method, the same was followed; however, now substituting corn cobs in the first four layers. The first layer has large longitudinal sections of corn cobs, while the second, smaller pieces of the same. In the third layer, she pulverised corn cobs into a powder form using the mortar and pestle available in most kitchens to grind masalas. The fourth layer has activated charcoal that results from the burning of corn cobs in a furnace to produce what Lalita calls sand charcoal. In the last layer, the water is filtered through fine sand.

As purifying water at the source prevents bio-magnification (the process by which compounds such as pollutants or pesticides increase their concentration in the tissues of organisms), a simple way to do this at the grassroots level was designed. Lalita tied a few corn cobs to bamboo sticks at different heights and placed them in waterbeds of small waterbodies such as ponds and lakes. This proved to be a workable, cost-effective method of particular value to farmers who tend to use a common water source to irrigate fields and for household needs. The readily available corn cobs cleansed the water of any chemicals that might have polluted it as rainwater runoffs often carry impurities in them. In homes, the 'new' filtration system is attached to outlet pipes. Industrial units use it to treat the effluent before it is discharged into waterbodies. The documented results of experiments confirmed the following. The contaminants removed include common

and magnesium salts, detergents, dyes, grease and oil as well as suspended particulate matter. For industrial wastewater, the papillae on the cob even filtered out heavy metals such as iron. Scientists at India's Central Science and Research Institute of Minerals and Material Technology in Bhubaneswar confirmed the efficacy of corn cobs with greater precision through experiments conducted in their sophisticated laboratories.

The challenges that Lalita is still working on is finding an easier way to grind the corn cobs to produce activated charcoal through sand charcoaling. Lalita looks upon these as minor irritants. 'I will soon find answers for these' she confidently says. That her name is etched in gold is clear with the many accolades she receives. Winner of the Google Science Fair, for example. Hear her speak on TED Talks and you know that this is just the beginning. Do we have a future Nobel laureate in our midst?

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Fix for Life

Fix for Life

Have you ever passed by a roadside faucet gushing out water with no one in sight making use of it? Perhaps, as a Good Samaritan, you tried to stop the wasteful flow. Often, such good intentions remain unfruitful, because upon closer inspection you will find no stopper to stem the flow.

This, unfortunately, is not an unusual case. For example, the Kolkata Municipal Corporation (KMC) supplies around 1.7 billion litres of filtered water to permanent buildings daily. For a few hours, 17,000 roadside faucets installed by the KMC, also receive supply to help those without connections at home to avail water. Around the set time when the faucets are scheduled to gurgle, you find people queueing up, anxious to fill buckets, wash clothes, or even bathe. However, not all the water that the KMC supplies is put to good use. A survey revealed that at least 10% of it is wasted owing to faucets that have damaged or missing stoppers. This loss results in less water available for distribution to those who could make good use of it.

It pained two socially-conscious youths of Kolkata, Ajay Mittal and Vijay Aggarwal, when they passed by one such broken faucet. 'Are there many more of the same?' they wondered. The next Sunday, they got their scooter out and drove around the city on a reconnaissance trip. They were aghast to find so many faucets mising stoppers. Back home, they posted their anguish on social media. Responses poured in from others who knew of many more. Ajay and Vijay plotted the sites on a map that soon got dotted with the numerous zones where water was going waste. Their estimate of the vast amounts of the precious H_2O going unused was heartwrenching. The duo committed to spending their weekends to help stop this and provide a 'Fix for Life' (an apt name for their efforts) towards conserving a resource so essential for survival.

Idealism is great, but from where would they secure the funds to procure materials and pay plumbers? The initial capital came by pooling their resources. This inspired family and friends to follow suit in support of the cause. A plumber was hired. Drives were planned to follow a predetermined route based on the map. This did away with frittering away time and unnecessarily spending fuel crisscrossing the city. Some areas, such as slums, were difficult to reach. KMC went by most need when choosing spots to fit the roadside faucets, and many shanty areas made it to this list. Approaches to reach the faucets here were only via narrow, congested lanes. Thanks to their two-wheeler, Ajay and Vijay easily and quickly negotiated twists and turns. Even jaywalkers didn't pose a problem.

In the beginning, fixing the faucets took a fair while. Now, Ajay says, he can replace a tap in under a minute! Many of the areas they work in are heavily populated. In the process of fixing the faucets, the duo address the ready audience that gathers around, about the possibility of a grim future in which taps run dry. 'Fix the faucets now, save every drop of water, or you might have nothing to fix later,' they say. The two made sure to praise any whom they learned had made efforts to temporarily plug the flowing faucets (with a rag or a piece of wood). 'Now you won't have to do that. Just ensure the stopper stays,' they advise.

After working on 800 faucets in Kolkata, Fix for Life set its sights on the twin city of Howrah. Here, the team was on unfamiliar ground. Ajay says, 'This was not our regular beat as we live across the river. We are grateful to the Howrah Police who agreed to map areas with missing faucets for us.' Vijay adds, 'Getting a ready-to-use map of areas that needed fixing cut down our hours of research to zero.'

In five months, the two inspected some 10,000 faucets. Of these, 1,500 were retrofitted with new plumbing that allows people to regulate water flow as per requirements. But all is not so rosy. In cases where the KMC water pipes are majorly corroded or broken there is no quick fix. Where the issues were minor they repaired these. 'To see the look of joy on people's faces once water flowed again is worth a million bucks!' they say.

Ajay speaks about the amazing goodwill they receive from people. 'They find it hard to believe that we spend our leisure hours, charge nothing, all with just the good of humanity in mind.' Today, the duo has inspired many others to join them as members of a formalised NGO, Active Citizens Together for Sustainability (ACTS). 'The media widely covers our work. The Government of India's Ministry of Jal Shakti (Water Power) named us Water Heroes,' Ajay and Vijay proudly state.

What a simple yet effective way to save water. 'Please fix any leaky faucet you come across,' is one of the green acts Ajay recommends in his 'Layman's Guide to Conserve Water.'

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Flush Me Not

Flush Me Not

Nestled in the Trikuta (three-peaked) Hills of the Union Territory of Jammu and Kashmir, at a height of 5,200 ft, is the temple of Vaishno Devi. Multitudes of devoted pilgrims visit the shrine, which is considered holy by Hindus. Devotees travel from across the world to pay their obeisance to the goddess and request HER benevolence to grant their wishes, for SHE is known to do so.

With determination, grit and faith, pilgrims begin a daunting 13-km trek up the rugged terrain from Katra in the foothills. As they traverse the path, they stop at places the goddess is believed to have spent time observing various spiritual disciplines and penances. At the culmination of the trail, they arrive at the Holy Cave where SHE merged HER human form with the astral form of HER creators (the three manifestations of the Hindu Trinity).

The Shri Mata Vaishno Devi Shrine Board manages the holy shrine. This is no mean feat, as it is responsible for ensuring that adequate facilities are available for over 10 million pilgrims who visit the temple annually. The remarkable efficiency with which this is accomplished has earned Vaishno Devi the distinction of being one of the country's best managed religious sites. The Board makes meticulous plans for the comfort and security of the visitors. Furthermore, great care is taken to ensure the policies formulated don't harm the natural ecosystem of the revered hills in any way. Adopting a multi-pronged approach, the Board aims to make the shrine area a zero-effluent, zero-waste zone, with proper sanitary and drinking water facilities. Mr Ramesh Kumar, IAS, CEO of the Board, says, 'Even when we have to upgrade infrastructure to cater to the needs of the ever-increasing flow of pilgrims, we do that with reverence to nature in mind. For example, the runoff rainwater from the Trikuta Hills slopes is conserved in a complex of water harvesting structures, micro-check dams, and vegetative check dams. This adds millions of litres to the groundwater. Additionally, sewage is treated to make it safe to be drained into natural streams.'

As part of the Board's continuous aim to provide eco-friendly facilities to pilgrims, it decided to conduct a pilot project to install 'Flush Me Not' urinals along the pilgrimage route. All along the path from Katra upwards, are placed interesting visuals that explain the use of the 'Flush Me Not' urinals to the pilgrims. Encouraged by the success of the initial project, the Board has now converted all the 324 conventional urinals in the shrine's zone into waterless ones. On an average, each time you flush, 1.5 litres of water go down the drain. Just think of the enormous volume of water saved. With their forward-thinking policies, the board has helped save around 12,000–13,000 litres of freshwater earlier used per urinal per month. This translates into a net saving of four million litres of water per month!

The waterless urinals work through a combination of three products: urinal screens, odour eliminators, and drain cleaners. The screens are made of recyclable Ethylene-Vinyl Acetate (EVA) polymers placed inside the urinal pots. These have polymerised fragrances and polymer-based delivery systems that are safe to use and dispose of. The Odour Eliminator uses non-pathogenic bacteria and enzymes to remove the foul smell, urine stains, prevent clogging and release a pleasant fragrance. This is why the waterless urinals don't stink when compared to conventional ones. The Drain Cleaner, a concentrated biological formulation, is specifically designed to maintain the grease traps, drain line treatment, wet wells and sewage injection pits. Before installation, the urinal is cleaned with diluted descaling solutions and a toilet sanitiser. The urinal's water supply is then disconnected, the screen placed on the urinal drain, and the Odour Eliminator sprayed on the surface.

No special expertise is needed for regular cleaning and maintenance work. With basic training, local hires are competent to replace the screen and Odour Eliminators every month. In recognition of the Shri Mata Vaishno Devi Shrine Board's water conservation efforts, the Ministry of Jal Shakti, Government of India conferred upon them the distinction of winning the 1st Prize of the National Water Awards, 2019 in the Best Religious Organisation for Successful Campus Usage category. So well deserved! The work of the Board aptly proves that with effort and single-minded purpose, anything is achievable.

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For the People,
By the People,
With the People

For the People, By the People, With the People

In 2002, the NGO Jal Bhagirathi Foundation (JBF) was established in response to the burgeoning water crises facing the Thar Desert's inhabitants in Rajasthan State. JBF's programmes, activities and strategies have a singular goal: to involve, empower and make the village community self-reliant through a participatory approach.

JBF works in an area of the state known as Marwar (or desert land). Despite its inhospitable climate, Marwar has a long history of attracting settlers to it, making it perhaps the most populous desert space anywhere in the world. Here, water is considered a common property resource. Over generations, traditional community water management systems established assured drinking water for all. The matrix for these was embedded in a holistic and ecologically prudent rhythm of the *Agor* (catchment area), *Gauchar* (pastureland) and *Oran* (sacred forests which were once repositories of biodiversity). From here, the community harvested the water to fill *talabs* (village ponds) and *naadis* (grassland ponds) located on the outskirts of the village. Over time, the village's social fabric disintegrated and the traditional water management system, abandoned. The result, an increased dependence on the government to supply drinking water.

JBF recognises the vast potential of people coming together as a way to water security. To resurrect what was once a successful working system, JBF chose a grassroots enabling approach (rather than a delivery one) and worked to set up strong *Jal Sabhas* (village water user associations) in villages located in the districts of Jodhpur, Pali, Barmer, Jalore and Jaisalmer. JBF trained the members to plan, implement and maintain water projects. Community institutions, (*Jal Samitis* at block levels and *Jal Parishads* at project levels), coordinated and monitored the *Jal Sabhas*.

To encourage ownership, communities are mandated to raise at least 30% of the infrastructure costs through cash contributions to the *Jal Kosh* (development fund). To ensure a formal, transparent, accountable system, funds can only be deposited in the registered bank accounts of the *Jal Kosh*. Once construction is completed, a decentralised system is set up by the *Jal Sabhas* to collect usage charges to cover maintenance costs. Just as importantly, this reins in any tendency to waste water since one has to pay for it—nothing is free.

A major challenge to the success of rainwater harvesting conducted under this system is the quantity of rain the areas receive. To harvest maximum water, the 'Community Led Water Management Systems' taps every drop of water that falls from the heavens in the catchment areas and diverts this through water or feeder channels to surface water-harvesting village reservoirs. In addition, the construction of *tankas* (underground water harvesting tanks) is promoted in community and school spaces. *Tankas* harvest water and act as receptacles to store water transported from common sources during dry spells. Household *tankas* are constructed within the premises of beneficiaries. By bringing the water closer to home, it reduces the drudgery of women and the girl child as it saves them the effort of walking 4–6 km per day to fill a 20 litre pot of water and carry that back.

JBF recognises that sustainable solutions to the drinking water problem are achieved only if women, the real 'managers' of water, take control. Thus, they promote a gender-sensitive approach. All the *Jal Sabhas* they facilitate have a minimum of 20% women members. That the efforts bear success is evidenced by women coming forward to form all women's *Jal Sabhas*.

UNDP commissioned an external evaluation of JBF's effort, which noted, 'As a result of the project interventions, water availability in the project villages had increased and the expenditure on water purchase by communities reduced by 140%, having a major impact on poverty reduction… women and girl child...have more time for productive work.' Similar conclusions were also reached by the Italian Ministry of Foreign Affairs. They also added: 'improvement of health conditions, above all for women and children, with a consequent reduction of health expenditure, social inclusion of the most underprivileged social classes in the water-users association, with a percentage of about 50%, decrease of conflicts due to greater water availability, which contributed to the greater social stability.' The 2016 evaluation by the European Union named JBF 'One of the best examples of good practices and the project approach to consultations and implementation, identification of communities and the selection and construction of the most appropriate solutions to improve access to water, as well as community ownership development, are all excellent examples that can be considered for replication. The project is highly recommended as a flagship project for water and sanitation initiatives elsewhere.'

These testimonies and the many national and international awards strongly endorse the JBF-supported people-led movement to safeguard water in Marwar. The statistics of achievements are mind-blowing. These include 6,00,000+ beneficiaries. 500 villages covered. 2,000+ water harvesting structures established. 4,000+ million litres of water harvested each year.

Kanuprlya Harish
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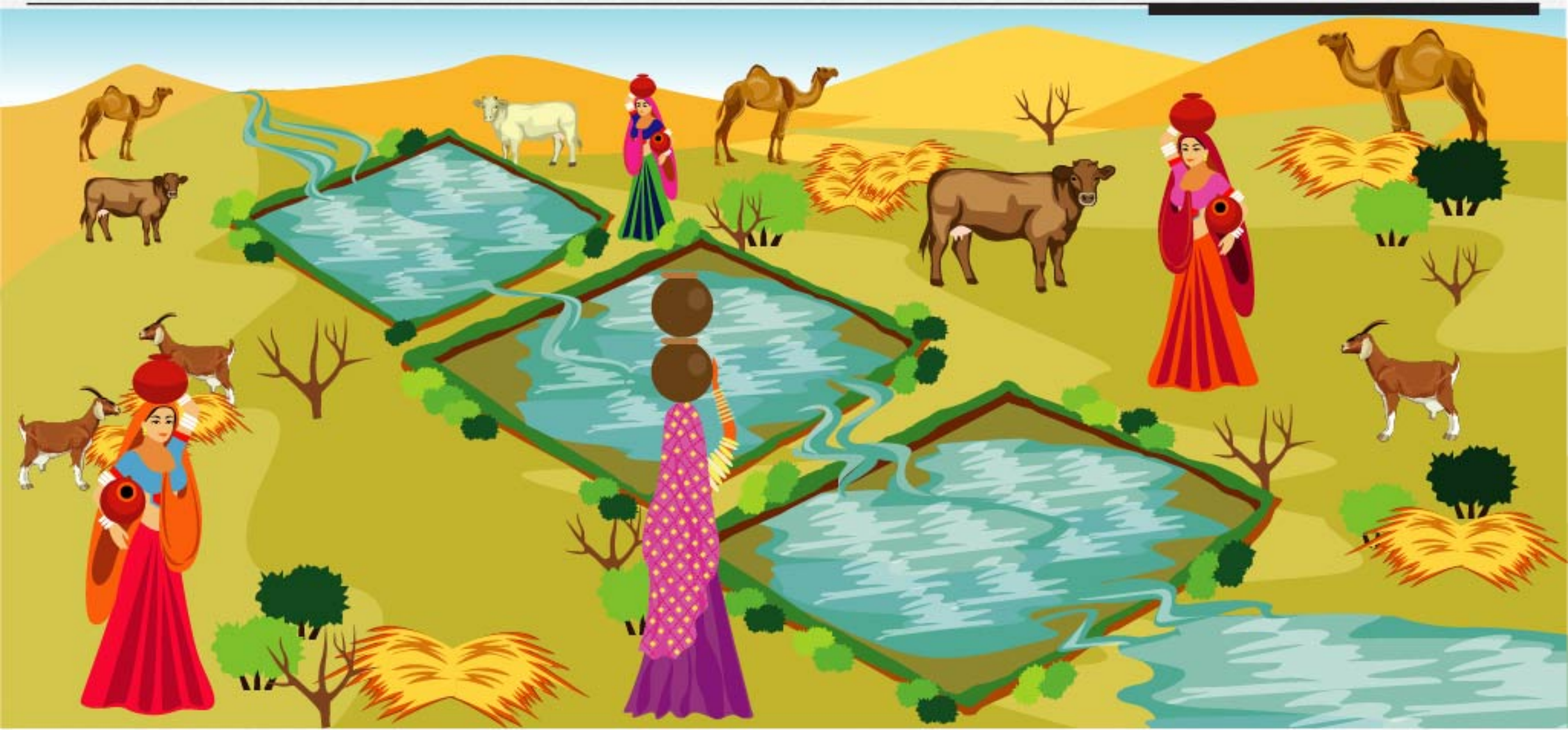
Four x Four



Four x Four

In 1977, parts of Rajasthan faced severe drought. People suffered greatly from the lack of water. Everyday life was affected by inadequate supplies of this precious commodity for cooking, washing and drinking. In areas where the major source of livelihood is animal husbandry, this also impacted earnings. Dehydration killed goats and cattle, as did deficient sustenance, since hardly any green pasture was available for them to graze on.

The immediate result was a huge exodus of people from the water-starved areas to nearby towns in search of employment. Laporiya village was no exception. It witnessed long queues of people abandoning their homes. Laxman Singh, a 17-year-old resident of Laporiya, was perturbed seeing this. Unlike many who left, Laxman opted to stay. 'Mark my words, I will create conditions that bring our people back,' he promised the villagers. For that to happen, he knew he had to prove to the migrants that an adequate supply of water had returned. Many in Laporiya mocked him and thought he had lost his mind. 'Where is water going to materialise from when everything around is dry?' they questioned. This didn't bother Laxman, as he was confident he would prove them wrong.

Knowing that he couldn't achieve his aim single-handedly, Laxman Singh inspired those that stayed back to join him to form the NGO Gram Vikas Navyuvak Mandal, Laporiya (GVNML). The most urgent task was to devise a system that caught every drop of water nature provided, stored it in overground water bodies, and facilitated it saturating the soil, to transmute the land from an arid to a moist state.

To design and develop a system appropriate to meeting local needs, GVNML workers conducted many hours of research. They meticulously studied already implemented projects to shortlist favourable ones. Long discussions with scientists were held at institutes in Rajasthan, such as the SKN College of Agriculture, the Central Sheep and Wool Research Institute and the Central Arid Zone Research Institute at Jodhpur. Visits were made to the watershed development projects of the Directorate of Watershed Development and Soil Conservation and the Forest Department of the Government of Rajasthan.

Ultimately, the unanimous decision was to implement a unique, ingenious technique, locally referred to as *Chaukas*. This in-situ rainwater conservation method has proven success in rejuvenating degraded grasslands and pasturelands (*charnot* and *gauchar*) in arid and semi-arid areas.

A *Chauka*, as the name suggests, is a four-sided structure. The enclosure has three sides sloped to end in flat, earthen bunds or dykes that hold water to depths of 9 inches when full. A series of *Chaukas* is constructed at predetermined spots along slopes to catch every drop of rainfall. As the water winds its way down, the first *Chauka* intercepts the runoff and contains it. Any excess moves down to fill another. While trickling down, the water also percolates the ground it traverses to render it conducive to green growth. To calculate the construction's requirements, an easy formula is: if the land slope is 1% (1 ft depth and 100 ft length), the side bund needs to be 100 ft on one side and 90 ft on the other.

The people of Laporiya say the *Chaukas* have reduced the velocity of the gushing water to less than what would cause soil erosion. In the absence of the *Chaukas*, the runoff would wash away (and thus waste) the fine, fertile sediment, rich in organic matter. The prevention of water gushing to the bottom encourages the growth of vegetation in areas that were earlier bare slopes. At the bottom, the water is stored

in ponds (*naadis*). This helps recharge the underground aquifers as water seeps into the land.

Chaukas are of several types. The selection of the appropriate model for construction needs to keep in mind prevailing socio-economic, physiographic, demographic, soil and climatic conditions of the area under consideration. One type is for uniformly sloping grasslands with a unidirectional slope of a maximum of 1.5%. Another, is more effective and appropriate for areas in which natural drainage lines or waterways already exist. A third is the best choice for areas with undulating topographies. This model is effective when there is an uneven slope of up to 3%.

Laxman Singh says, 'To ensure maximum success, I urged the entire community to come forward and take part in all phases of the *Chauka* system—from the initial decision to construct, to the fair distribution of the benefits. Of course, we faced many issues. But the strength of the majority's voice helped tide over these. For example, some greedy moneylenders opposed the system as their poorer clients no longer needed to borrow money to tide them over the water crisis. Another problem arose with sparse areas turning lush. This attracted encroachers. Shifts in soil patterns needed regular reviews and required redirection of the *Chaukas* to ensure the system continued to provide excellent results. We have overcome all these,' Laxman confirms.

The word soon got out that, miraculously, Laporiya now had enough water to cater to the villagers' needs. Laxman Singh beams every time a villager returns home. 'God be praised,' he says, to which the villagers add, 'And our deepest gratitude to you, Laxman Ji.'

Jagveer Singh
Chief Executive Officer

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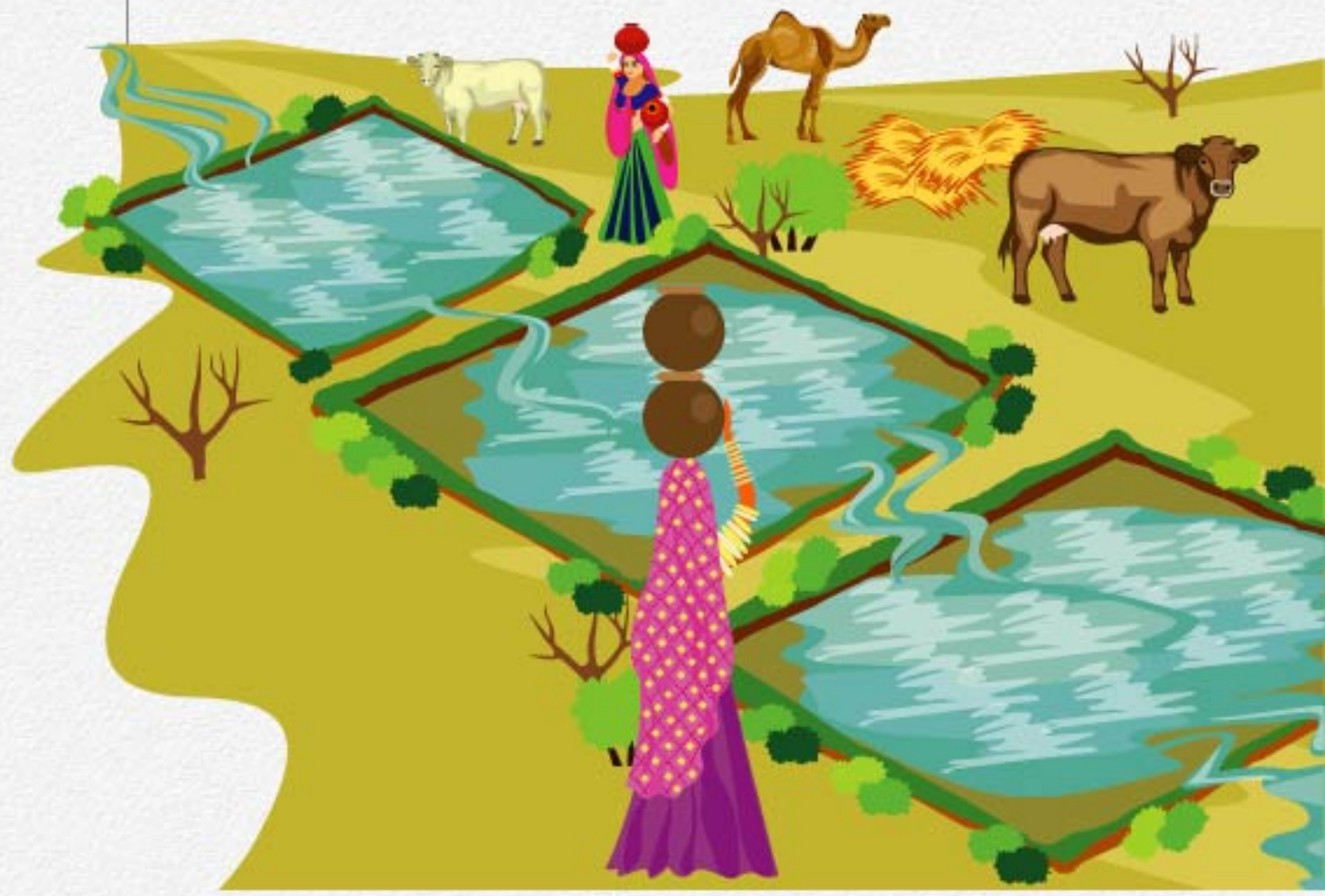

Glass Half Full

Glass Half Full

Do you wonder why the famous poem The Rime of the Ancient Mariner has the lines 'Water, water, everywhere, Nor any drop to drink?' This is true, for only as minuscule an amount as 1% of all water on earth—in oceans, seas, rivers, and varied aquifers—constitutes available freshwater. Much of the 2.5% of our planet's freshwater lies trapped in glaciers and snowfields, leaving only a very tiny amount for use. That makes every drop of this vital resource so very precious.

'India's Water Girl' is the honorific conferred in 2020 on Garvita Gulhati. It is one she richly deserves. As a 15-year-old, she came to learn that close to 100 million homes in India were without proper access to water. This had a profound effect on her. Additional research threw up more startling facts. As much as 14 million litres of water a day ends up in drains, thanks to the eateries we all frequent. From the smallest wayside *dhaba* to five-star hotels, the scenario is the same. Investigations confirmed that much of the wastage resulted from servers routinely filling customers' glasses to the brim; as well as guests who had no compunctions about leaving a glass half drunk. 'Yet, there are millions who barely get enough water to quench their thirst, while others walk for miles to get this nectar,' Garvita points out. Hearing stories of severe water deprivation moved her to tears. She was determined to find a solution to stop the misuse. 'Why waste?' Garvita questions. 'That is so criminal,' she says. She hit on an amazing idea to 'change the world, one glass of water at a time.' That was the genesis that led to the creation of her non-profit organisation 'Why Waste?' Her team members are environmentally-conscious millennials, determined to delete the figure of 14 million litres of wasted water from records. As a first step, they visited eateries to explain to owners and servers why saving water was so crucial. 'Why don't you fill glasses only on demand?' they suggested. 'Look at the quantities left undrunk in a majority of them, all of which will go to waste,' they pointed out. However, changing ingrained habits is not easy. 'It was no smooth sailing,' Garvita shares. Restaurant owners scoffed at taking advice from youths and continued filling glasses to the brim, whether customers asked for them to or not. 'Why should a customer have to ask?' the owners retorted.

To work out a win-win solution, Garvita came up with #GlassHalfFull. The campaign is so simple to implement yet so effective: just fill each glass till the halfway mark and refill only on demand. Restaurants were extremely sceptical but Garvita and her team didn't give up. Finally, Napoli, a restaurant in HSR Layout in Bengaluru, found merit in the idea and agreed to give it a shot. It saw phenomenal success! Garvita used the case as a testimonial to reach out to other restaurateurs. She says, 'To further spread awareness, we created tent cards and asked people to share images of their empty glasses on social media.'

Today, Why Waste's? #GlassHalfFull movement has gone viral. Apart from India, it is active in eight other countries. The organisation continues its work to help change mindsets, optimise usage and prevent wastage of water. To widen water positivity, members help educate and change behaviours regarding water among a range of citizenry, from school students to office goers to grandparents. Interesting inclusions to their social media outreach are the fables and fairytales created by many to inspire young adults to help children inculcate water conservation values at an early age.

Why Waste? has already prevented the wastage of six million litres of water. 'We have reached more than ten million people through our impact activities,' Garvita proudly declares. The organisation is recognised as India's largest youth-led organisation working to conserve water. With support from

the National Restaurant Association of India, 5,00,000 establishments across the country now participate in this movement. Why Waste? is also the sole knowledge partner for CNN's Mission Paani (water). The NGO was named 'Water Heroes' by India's Water Ministry.

Garvita herself is the recipient of several awards, including the prestigious 'The Diana Award', conferred in memory of Diana, Princess of Wales and her belief that young people have the power to change the world. Garvita's opinions are highly regarded. She was on the board of the Changemaking Centre at the University of San Diego and was part of the State of Youth, based in New York. She also helped launch Lead Young in India with Ashoka Innovators for the public, which is the world's largest network of social entrepreneurs.

The #GlassHalfFull campaign helps solve the global water crisis with a positive look at the metaphor of half empty. 'Let's see the #GlassHalfFull,' Garvita suggests. Such a simple idea, but what a huge benefit for all of humanity!

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Green Aquifers

Green Aquifers

To repeat an almost universal concern 'how do we combat the impending global water crisis?' Presently, water tables are overdrawn, there is reduced discharge into rivers and other water bodies. At the same time, the need for water has increased across several spheres of life. To this depressing scenario, add another problem—global warming. Higher atmospheric temperatures exacerbate the issue as there is a faster rate of evaporation of water.

Aside from water, what else is imperative for our existence? No prize for answering 'food.' Food shortages are positively co-related to water shortages. Without the required amount of moisture in the soil, crop yield and its quality get negatively impacted. Consider the evaporation of water from the top layer of soil. Can a reduction in this be initiated so that farmers require less water to irrigate their lands, thereby saving both water and expenses? Can agricultural productivity improve without having to give up on additional water? Is there a way around this high trade-off of choosing between water and food?

'Water Retainer' is a product that provides a win-win response to all these questions.

Valoric Venture is the distributor of a pioneering green solution named 'Water Retainer'. Water Retainer is a patented water-based solution of organic hygroscopic and surfactant substances of vegetable origin and substances used in the food industry. Its application results in positive effects on the soil's health and on vegetation. This makes for efficient water use and helps recharge and create aquifers. Water Retainer attaches itself to both the roots of the plant and soil grains. This allows rain, precipitation and irrigation water, to enter the soil and trickle down to the water table, leading to increased water reserves. Water Retainer is applicable to all crops and soil types. Although it gets attached to both soil particles and the root system after application, it does not modify them. To further enlighten agriculturists, Water Retainer does not require any major changes to the existing farm work practices. It is also an insurance cover against 'Flash Drought', a phenomenon that climate change has turned from occasional to frequent.

So how does it work? Applying the Water Retainer helps plants and roots retain soil humidity by reducing evaporation loss (capillary effect). It also traps and keeps air humidity (higher humidity of the early morning hours) in the soil in a form that roots can uptake. This translates into plants requiring up to 50% less water for irrigation. The consistent moisture present in the soil results in better seed germination and increases microorganisms. Crops thus can withstand longer periods without irrigation/rain. In dry and extreme drought periods, plants may survive up to twice as long without water as the effects of dehydration are diminished. The ideal water content in soil results in improved nutrient uptake and better hydration of plants. The Water Retainer process helps initiate on the soil surface, the formation of humus to act as organic fertiliser. Effective plant hydration and healthier plants result in enhanced crop yields.

It takes the Water Retainer about three months to degrade in the soil. One can extend the period of its efficacy by applying booster doses. The water content remains higher in such treated soils than that in untreated ones. Water, a sadly diminishing natural resource today, is made readily available for alternate critical applications at zero or negative nett cost' to the economy. For example, drinking water, which is already an urgent need today, will have even greater demands on it by the swelling population whilst requiring higher agricultural productivity.

As per climatic conditions, different dilutions of Water Retainer are recommended for spraying on soil surfaces. In India, the GB Pant University documents the success of Water Retainer's applications to grow Sprouting Broccoli (*Brassica oleracea italica*). In Dibrugarh, the Assam Company utilised Water Retainer in their rainfed tea plantations and recorded a 12% increase in crop output. Private farm holdings with fruit, vegetables, pulses and wheat crops have also documented successes.

Vinay Verma, MD of Valoric Venture says: 'Water Retainer is a unique innovation that helps reduce cost whilst naturally increasing agricultural productivity and simultaneously creating water reserves for the future. The time has come for companies and the government to make a green and sustainable business a norm. Green technologies and innovations are the way forward. We will cease to exist should we continue to disregard our natural resources. Adoption is imperative to combat change.'

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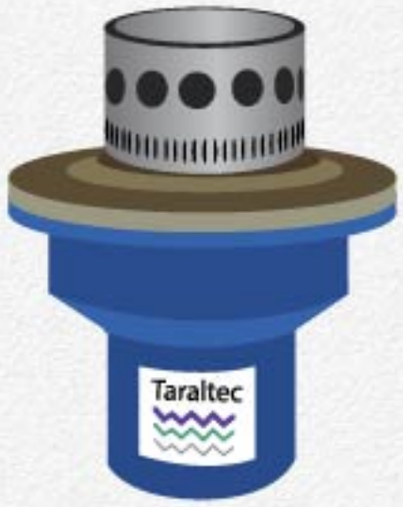
Guarding the Unguarded



Guarding the Unguarded

As we say, water is life and, yet, if contaminated, it becomes a taker of life. In India, it is estimated that a fifth of all diseases are water related. This, to varying degrees, is a global issue. The WHO and UNICEF Joint Monitoring Programme Report (2015) estimates that 1.4 billion people in some 36 countries are likely to be the unfortunate recipients of water contaminated with disease-causing microbes and pathogens, not years from now, but as early as 2025. This is because conventional methods to purify unsafe water remain inadequate, limited as these are by monetary drawbacks and carcinogenic hazards. The fact that these methods also increase the carbon footprint is another negative. For example, 15 g of CO_2 is emitted for every litre of water boiled.

But don't lose heart. Taraltec® Reactors is a solution that turns unsafe water pumped up through hand pumps attached to borewells to one with a 99% plus reduction in microbes. The Government of India's Ministry of *Panchayati Raj* (local self-government) identifies the Reactor as one of the most effective means to provide safe water in rural India.

The device is a first-in-the-world innovation of Taraltec Solutions Private Limited, a start-up instituted in 2017 by brilliant scholars Anjan and Piyul Mukherjee. This husband-and-wife team counts the Indian Institute of Technology, Bombay, as their alma mater. Both also received post graduate degrees in management from some of India's most prestigious institutions. Their genius lies in the fact that they invented Taraltec® Reactor with amazingly simple technology. This game-changer works on principles of physics that are inspired by biomimicry. 'It is not a filter, but a technology that puts science to good use,' Anjan emphasises.

The tiny device (it weighs around 1 kg) is a palm-sized 'fit and forget' pathbreaking object that requires no consumables, no energy, no chemicals, no maintenance, nor any supervision. It is easy to retrofit existing hand pumps with it. The Reactor lasts the lifetime of the pump. Piyul says, 'It takes less than an hour to install. The fitter needs no special tools or training. All one needs to get safe water is to crank the hand pump. As the device reacts to the movement, it works its magic. Anyone can operate it. Even older people who work the pump to get the water they need.'

So, how does it emulate the natural world? The answer is, the Reactor is inspired by the behaviour of the snapping shrimp, Alpheidae. This creature attacks its prey by snapping its claw to shoot a water jet causing cavitation bubbles to form as the ambient pressure goes below the vapour pressure. On recovery of the ambient pressure, the bubbles implode with an intense localised energy release. For a tiny fraction of a second, the temperature in the bubble soars to over 7,000°C. Yes, for a split nanosecond, it is close to the temperature of the surface of the sun. This is what lacerates the microbes.

Anjan figured out that this phenomenon could also help stun and kill the microbes in the water to render the water disease-free. The Taraltec® Reactor is thus developed to create and collapse precisely tailored bubbles, to modulate the pressure, temperature, turbulence and the formation of free radicals as a result of the cavitation phenomena. The kinetic energy of the fluid passing through the borewell hand pump gets converted into millions of targeted microbubbles, each of which acts as a localised reactor. This is packed with extreme heat, pressure and turbulence that releases intense energy packets during the bubbles' collapse. The resultant shock waves physically kill microbes and deliver safe water to the drawer. What a wonderful way to insure people against disease!

The start-up focuses on under-served areas of the vast Indian geography where the only water source is borewells The couple has fitted the Reactors in villages across various districts and states of India. The device has already positively impacted the lives of close to a million people all over India by providing them with safe water. The device's price is kept affordable (less than ₹8,000 each) thanks to minimised operations costs as a majority of the work is either done by the duo themselves or subcontracted. Even the initial capital for fitting the device is minimal, with the result that each litre of emerging water comes at an unbelievable price of decimals of just one rupee.

Since its inception, the Taraltec® Reactor continues to be felicitated as a pathbreaking invention. Most recently, Taraltec Solutions Private Limited received the 2020 National Start-Up Award (Water & Water Network) from the Government of India. Anjan is also selected to be a Fellow and a Leader in Innovation by the Royal Academy of Engineering, UK. This bootstrapped start-up seeks support to reach the Taraltec® Reactors to a population of over 500 million in the rural areas of India alone. And several billion across the world. 'There is a long way to go! Every citizen of the world deserves to consume safe water free from microbes', the founders say.

Anjan Mukherjee, Piyul Mukherjee
Co-founders

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Ice Stupas

Ice Stupas

Nestled high in the Himalayan range of India's North is the mountainous state of Ladakh. This rugged terrain is frozen over for most of the year. In winter, temperatures there drop to around –14°C. Located as it is in the rain shadow of the mighty Himalayas, the annual rainfall received is limited to around 10 cm. Is it any wonder that the area is termed a 'Cold Desert'?

Survival is a basic human instinct and the inhabitants of Ladakh are worthy examples of living life with ingenuity. As the only water source is glacial streams that transform into flowing waterbodies at specific times of the year, most villages are located in their vicinity. Come April, when the sun's rays touch the inhabited lower regions and snow melts, fresh water is there in these glacier streams. First, a trickle forms, which gradually develops into small rivulets. As the sun's warmth continues to elude the higher reaches, the snow there however remains frozen. Thus, the villagers have to make do with whatever thaws in local streams. This is a pity, as spring is also the time for sowing and when fruit trees need sustenance to flower. Through a labyrinth of water chutes, the villagers have learned to ration the limited supply equitably to different fields.

In June, when the weather is warmer, the snows in the higher ranges begin melting as well, The rivulets now turn into roaring streams and the water comes cascading down. Sometimes, these streams even burst their banks, causing flash floods and havoc. It is then that the canals are used as shock absorbers, to protect areas from being inundated. Around September, autumn sets in and the glacial streams in the higher regions begin to freeze again. Unfed village streams shrink to small rivulets. This does not pose a major problem as farming is over by then; so much of the water is allowed to flow downstream unharnessed. A pity, as water would be greatly needed in spring, to restart the farming cycle. The challenge to devise a way is to store this precious resource through the winter months.

Chhewang Norphail and Sonam Wangchuk, two engineers from the region, found an innovative way to do so. They noticed that water pipes located in largely shaded areas continued to stay frozen during the warmer months. This was something strange, as everywhere else, water sources thawed. The observation led to the invention of 'Stupa Glaciers'. In autumn, when the sun sets and the air turns colder, water is cascaded down some 30–50 ft to areas that remain in the shade throughout the year. The chilly night air freezes the water as it descends. Upon landing, it forms an ice cone. No pumps are needed, just gravity. Piped water from streams is allowed to flow down. A chain of stupas can result from a single pipeline, just by perforating holes along the pipeline.

The prototype, created in 2013, was 20 ft high. It froze over 1,50,000 litres of water for use in Ladakh's capital city, Leh. This did not completely melt till as late as May of 2014. What a wonderful way to ensure that much needed water for agricultural use in the spring months was stored safely! It was noted that even if the stupas were located on the leeward sides of the mountains (thus receiving warmth from the sun), the vertical structures ensured minimal water loss. As these ice cones stand perpendicularly (unlike natural glaciers with large horizontal surfaces), only the pinnacles ran the risk of melting from exposure to sunlight. At the same time, the rest of the obelisk remained intact for use in warmer months.

So began the process of constructing ice stupas beside villages. Their form reminded the people of traditionally sacred mud structures known as *Chortens* (stupas). On average, each stupa provides two million litres of water. This is enough to support the total agricultural and domestic requirements of the people. Ice stupa making competitions are regularly held and crowdfunding and voluntary labour called upon to popularise

this novel method of storing water. To date, some 90 stupas covering 12 villages have been built, with plans for an additional 25 on the cards.

In 2017, Sonam Wangchuk was awarded the prestigious Rolex Prize for Enterprise. The citation reads, '…for helping farmers in the arid Himalayan highlands of Ladakh overcome water shortages by tapping meltwaters to build artificial glaciers.' Rolex also announced that it would support the project and promote ice stupas as a climate-change adaptation and desert-greening technique.

No complicated engineering, no rocket science; just harnessing the force of gravity and brilliant thinking is all it took to help turn this cold desert green.

Sonam Wangchuk
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Impounding Runoffs

Impounding Runoffs

Zabo is an effective way of water conservation developed by the ingenious tribal cultivators of India's North Eastern State, Nagaland. In the local dialect, the word means 'impounding runoff water'. This multi-tiered, self-organised, integrated and viable resource management practice propagates ways to ensure that every drop of rain is used optimally. The system supports a combination of afforestation, horticulture, animal husbandry, agriculture and pisciculture to keep the ecology in equilibrium. At the same time, it provides nutrition available at hand for the locals, obviating the need for obtaining it from external sources.

Nagaland has a varied topography of high hills and low valleys, necessitating area-suitable growing and rearing practices that make the best use of the prevalent land structure. In areas inhabited by the Chakhesang and Angami tribes, the traditional system is a terraced one. This sustains many food source genres along the hill slope—right from its apex to its base. Before *Zabo* was developed, the area faced periods of water scarcity, primarily due to surface water runoffs rather than inadequate rainfall. Today, the scenario has changed: *Zabo* provides the tribes an inbuilt continuum wherein water is harvested and recycled to grow ample produce, regulate soil erosion and increase ground fertility.

The *Zabo* system begins with the forested hilltops. The villagers carefully preserve these, keeping in mind their usefulness as rainfall catchment areas. Tradition discourages any felling of trees. From here, they channel the water into silt retention tanks constructed a little down the slope. The bottoms and sides of these reservoirs are rammed and compacted to reduce seepage. The water is stored in them for 2–3 days to allow the silt part of the runoff water to settle at the bottom. These tanks are cleaned annually. The soil unearthed is strewn in paddy fields as it is rich in organic matter. Now the water is directed down via inlet channels to harvest ponds constructed in the hill's middle. The pond is plastered on the inner surface with mud mixed with chopped paddy straw to minimise water losses. If required, more than one pond is built to ensure that the surplus water flows down to another pond below. At this level, horticultural produce such as squash, colocasia, cucurbits, banana, papaya, oranges and citrus are cultivated on the ponds' banks. On the embankments, a huge variety of medicinal plants and herbs are planted. Animal enclosures fenced with ordinary wood and bamboo branches are constructed below the water harvesting pond where cattle, goats, sheep, pigs and poultry are reared. When water is released through an outlet at the pond's base, it first nourishes vegetables that grow at a lower elevation and thereafter irrigates fields at the bottom of the valley. The transfer is facilitated through open channels or via split bamboo ones. Since the water has passed through animal yards, it carries the animals' dung and urine, which serve as natural fertilisers for the fields.

The system thus ensures that even if the rainfall is meager that season, there is adequate water to provide an average of two supplementary irrigations to paddy fields (rice is the staple food) and help harvest 3–4 tonnes per hectare. But that is not the end of the many uses of the water that has journeyed down from the hill's top. Farmers dig out a small pit in the middle of their rice fields and release fish fingerlings into the fields in July. The paddy matures by the end of October and the fields are dry by then. In case there is excess water, they drain it from the fields before harvesting the paddy. As the field dries, the fish swim into the pit, from where they are harvested. On average, there is 50–60 kg of fish production per hectare from paddy-cum-fish cultivation, providing an additional income source for the farmers.

Senior scientist Dr RK Singh says, 'This unique judicious utilisation of water continues over centuries because it has a strong scientific base and is easy to implement as it requires just locally available resources. With the absence of chemical use, groundwater is not polluted. Increased production thanks to the *Zabo* technique raises the quality of life of the people. *Zabo* also preserves the green cover, unlike *Jhum* cultivation practised in other parts of Nagaland where areas for planting are cleared by setting fire to fields. With minimal erosion and contamination of water, it also reduces the risk of flooding. All in all, a system that others in similar agro-climatic zones should consider adopting.'

RK Singh
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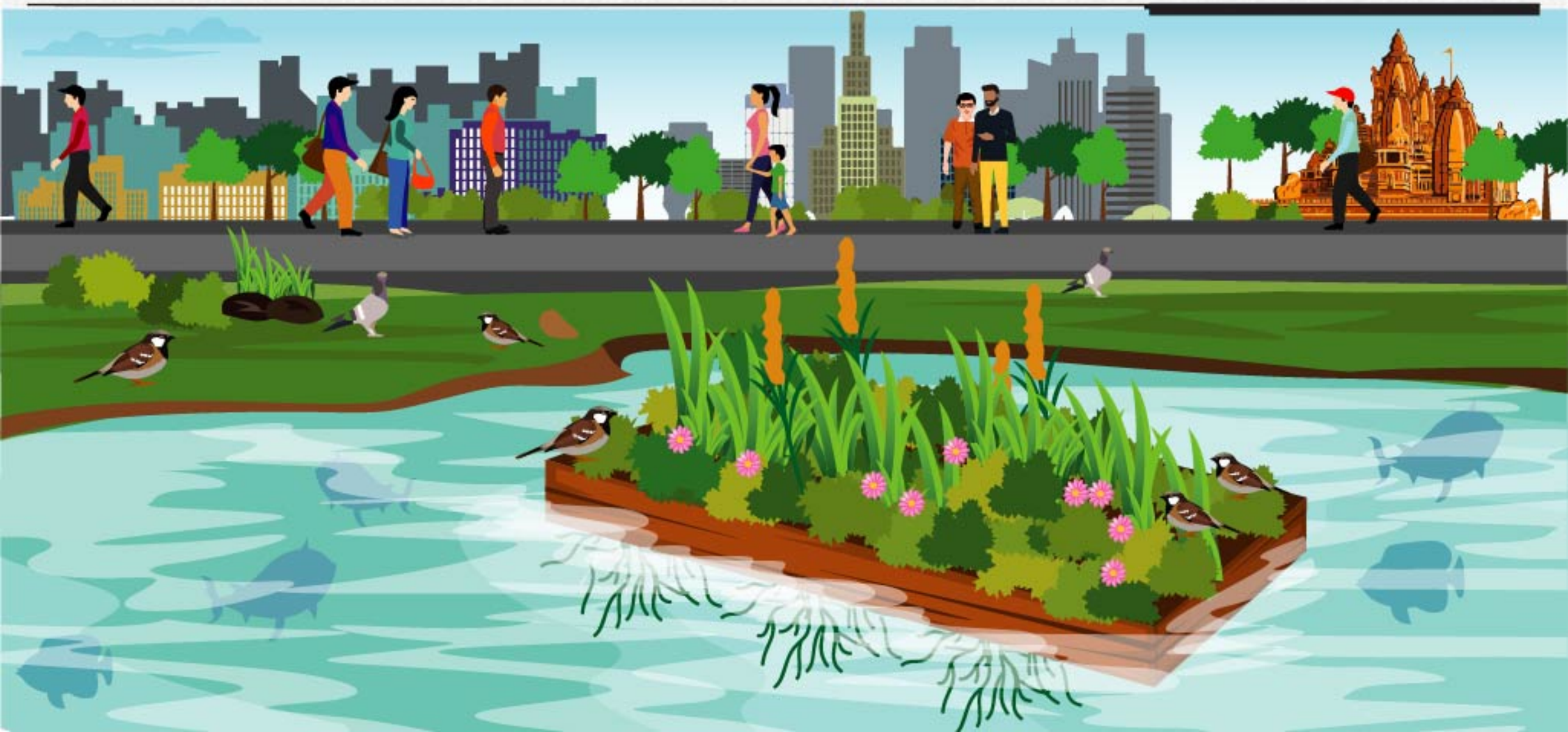
Islands that Clean



Islands that Clean

A not-to-be-missed spot in Indore, the largest city in Madhya Pradesh, is the 10,000 sq ft artificial lake, Nalanda Sarovar. Visitors marvel at the picturesque landscape that greets them of richly vegetated floating islands bobbing on the freshwater. The islands' profuse ecological growth attracts swarms of birds and other species who take refuge in these green havens. Vegetation can even be seen spilling over onto the banks. All this makes for an iconic picture of natural beauty that stands out in an otherwise over-constructed and over-crowded urban space.

The Sarovar was once an eyesore; covered with algae, duckweed and other invasive species that thrive on water pollutants. Today, its waters are clean. The change is thanks to the enterprise Clean-Water (Sustainable Water Technologies Pvt. Ltd.). The organisation is run by a group of young, enthusiastic professionals committed to finding sustainable solutions for the management of polluted water. This, they say, 'is the need of the hour.'

Clean-Water (Sustainable Water Technologies Pvt. Ltd) constructs modular floating islands that mimic a natural wetlands ecosystem. The result is a water filtration plant devoid of machines or chemicals. The floating islands achieve this by stimulating the development of friendly bacteria and plants with long roots. This effectively filters pollutants and other harmful elements from the water. The biofilm colonies compete for the same food source as algae and thus starve the latter out. The result is an increase in fish supply and water quality. Clean-Water (Sustainable Water Technologies Pvt. Ltd.) presently has 14 designs of tailor-made islands for various types of waterbodies—rivers, ponds, lakes and even the open seas. The sizes vary from small ones that fit a single aquarium, to bigger ones where farming can take place and mini orchards planted.

Floating islands are constructed using marine-grade, recyclable plastic, aluminium, or wood—material that is non-toxic to any living species. Fast degrading biodegradable material is avoided to ensure the longevity of the structure. Each floating island is layered with 2–6 inches of soil. Coco-Peat is added to keep the weight light and the structure buoyant. During the early plant growth period, the Coco-Peat also efficiently retains water. A layer of a special material below the island allows water to rise and roots to go down. The result is an ideal habitat for wildlife. As microorganisms begin to develop in abundance, the structures transform into conducive spaces, both on the surface and below the waterline. These provide sanctuary to participants in the ecological cycle. Invertebrates, insects, fish and birds (such as lapwings, cranes and peacocks), all find refuge here. When the water currents are high, as during the monsoons or when there is fast-flowing water, the floating islands are anchored to prevent them from drifting away. Their standstill position helps reduce the evasive action of water by breaking its force. That the islands also beautify the landscape is an added bonus. The flowers, fruit and vegetables organically grown on the floating islands, delight the citizens of Indore, who vie for a share of the produce.

The structures themselves require almost no maintenance. However, the plants growing on them do. While wetland plants are low maintenance (just once in 3–6 months), flowering plants added for aesthetic value need weekly care. The larger islands are firm enough to take the weight of the maintenance staff. The smaller ones are periodically tugged to the sides of the lake to let gardeners and others hop on to do their job.

Floating islands have proven to be extraordinarily high-quality, cost-efficient structures that offer a feasible solution to India's present water crisis as they both purify the water, and also help increase its quantity.

Clean-Water's success in Indore has now been replicated many times in other ponds and lakes. Priyanshu Kumath, the IIT Bombay alumnus who conceived this innovative method, says, 'While our islands are constructed off-site at the Clean-Water unit, our designs allow for their easy installation at the site itself. Even unskilled labourers can accomplish the task. Millions of waterbodies are in need of restoration, and time is short. Our scalable, product-based approach of shipping our islands to locations across the globe results in many more installed in a relatively shorter time. Because water is everywhere, so are we,' he adds.

There is indeed an urgent need for such innovative enterprises to revitalise our inland waterbodies—ponds, wells, rivers, canals and springs. Unfortunately, many, if not all, of these are presently more cesspools rather than sources of joy. As some of these drain into seas and oceans, those resources too are negatively impacted by the neglect of our inland waterbodies. The world definitely needs more forward-looking thinkers like Priyanshu.

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Ninety Percent Less

Ninety Percent Less

Kheyti (the Hindi word for farming) is an enterprise set up by kindred souls, all bound by a common thread of commitment towards farmers with small holdings. Its founders—Sathya Raghu Mokkapati, Kaushik K, Saumya and Ayush Sharma—gave up lucrative jobs to follow the call of their hearts instead. The Acumen Fellowship, at which some of them met, taught them to build products for the bottom of the pyramid, solve complex problems relating to ecosystems and utilise their leadership to benefit the economically challenged.

In 2015, the four decided to combine their knowledge and skills to develop systems to help farmers distressed by a morass of crop failures. Their on-ground interactions with people revealed that three of every five farmers were in a pitiable state. Further research confirmed that about 100 million farmers in India live in poverty and that, if given the choice, 60% of smallholders would happily change their occupation. This was shocking! 'If the people on the land don't find farming profitable, food security is under serious threat; for 80% of food production comes from small farms,' they reasoned.

Thus was born the 'Greenhouse-in-a-box'. This is a system that helps address four crucial factors that lead to crop failures: excess heat, attacks by pests, unseasonal rain and inadequate water. It is designed to adapt and implement low-cost farming solutions that help small farmers increase yields and improve their produce's certainty. The technologies are combined with end-to-end support that guarantees the farmers a seamless path towards expanding their incomes. Speaking about it, the founders of Kheyti say, 'Greenhouse-in-a-box is an affordable, modular greenhouse. It is bundled with full-stack services that use 90% less water, grow seven times more food and help farmers secure a dependable income. Our greenhouse and drip irrigation system, along with end-to-end guidance for farmers, is particularly designed for small farms. It reaches their owners through farmers' collectives and other groups. Our smallest greenhouse occupies merely 1/16th of an acre and the largest one 1/8th. This includes an installed greenhouse, a drip irrigation kit, seeds and fertilisers for the first season.'

The modular greenhouse's drip irrigation system helps save water and nutrients by making water drip slowly. This allows the water to soak in before it evaporates or is wasted as run-off. The water feed is focused only at the roots rather than spraying it all over the fields. The specially designed drip irrigation systems by Kheyti has four layers. Each helps prevent losses through evaporation. Typically, to grow an acre of crop, farmers need 50,000 litres of water per day for vegetables and more than 1,00,000 litres a day for paddy. Greenhouse-in-a-box helps produce commensurate harvests using just 1,000 litres of water per day!

G Venkat Swamy Dachram, a farmer in Siddipet, bears testimony to the benefits. He says, 'I have 3.5 acres of land, on which I have grown vegetables for the past 15 years. Kheyti's greenhouse needs only a small drum of 1,000 litres of water, and still earns me more money. Thanks to this, I now receive a revenue of ₹70,000 every 3 months in 5 gunthas (1/10th of an acre) of land. I have never seen such revenue in my life in the summer season.' One hundred and fifty other farmers have confirmed similar findings from 15 villages. As for installation, Kheyti's life-saving and life-changing technology for smallholder farmers costs 60% less than a traditional greenhouse.

The Indian Government's think tank NITI Aayog highlights that around 600 million Indians face high to extreme water stress. This is likely to double by 2030. This water emergency's largest impact is intensely lived and felt

by farmers as farming accounts for approximately 60% of the demand for water. The country's groundwater availability, which makes up for 40% of its water supply, is depleted at an unsustainable rate. Farmers presently have just 20% of the water they need for farming, and the situation is likely to worsen as a result of climate change. All this puts the agricultural sector at high risk as less and less water is available.

Kheyti richly deserves accolades for its climate-smart agricultural solutions that save water and double farmers' incomes. They have proven that the right technology and farm services for climate-resilient farming can raise millions of smallholder farmers out of poverty. The success of the initial installations by 150 farmers has encouraged 500 more families to take it up. Kheyti aims to reach 1,00,000 farmer families by 2025.

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Out of Thin Air

Out of Thin Air

Thousands of families in rural India are bereft of the privilege of opening a tap to find running water. The responsibility to provide water for households in such areas usually falls on the womenfolk. Young and old, they trek miles every day, often in the blazing sun, to collect water from ponds and rivers. Come tomorrow, and the routine will begin again.

Historically, settlements developed around waterbodies. Over the years, many of the sources dried up, necessitating women to go farther afield in search of potable water. Lines of women out on daily water walks make a pretty photograph when clicked through a telescopic lens. But look closer, and you will see the signs of toil on their torsos, burdened from carrying heavy waterpots.

The scenario was the same in Jalimudi, a village in Andhra Pradesh. City officials from the social enterprise, WaterMaker (India) Pvt Ltd were troubled seeing the women's hardship day-in and day-out. They put their heads together and came up with a solution. WaterMaker (India) Pvt Ltd developed a system that converts free-flowing air into safe drinking water using atmospheric water technology. The pilot project's run in Jalimudi made the village the first in the world to have an atmospheric water station that produces water conforming to IS 10500:2012 quality standards and WHO norms. They installed a 1,000 litre per day Atmospheric Water Generator (AWG) on land allocated by the village *panchayat* (local self-government) to serve the needs of all 600 residents of Jalimudi. Water tanks at the dispensing station provide thousands of litres of fresh, clean, purified drinking water. No trucks or pipelines are needed to deliver water. Nor did it come from a river, sea, ground well, or catch basin. For, as unbelievable and miraculous as it sounds, the water was 'made from thin air!'

The innovative technology uses optimised dehumidification techniques to extract and condense moisture in the air to produce pure drinking water. Blower-driven air is drawn into the system through an air filter. In the machine's housing, a compressor circulates refrigerant through a coil array placed in the air's path to provide a temperature differential that results in condensation. This water is collected in a holding tank where a switch controls the water-making cycle. The collected water is purified by a 7-stage filtration and purification system and dispensed through multiple dispensing points, or stored in external tanks to be dispensed by taps. The atmospheric water generators perform as per their rated capacity, provided the average temperature is between 25°C and 35°C and the relative humidity between 70% and 75%. If the Rh levels are higher, more water will be produced and vice versa. The equipment for extracting water from the air has UN Classification under UN Code 181100.

There is no depletion or contamination of natural wealth. The reasons for this include zero requirement of a water source, and barely any wastage of water during the purification processes (the opposite is true in Reverse Osmosis and desalination). There is no reject water produced that can contaminate ground or seawater. Besides, non-biodegradable waste is not generated as no plastic bottles are required.

To begin with, WaterMaker (India) Pvt Ltd faced many challenges. No one knew of this technology, so it took time to convince the local self-government's members about its benefits before they agreed to allocate land for the project. Cables needed to be drawn for a 3-phase power line. The local power authorities worked on making this happen, as did other officials from different government departments. 'It was a team effort. Many government departments joined hands to ensure that the miracle happened,' say officials of WaterMaker (India) Pvt Ltd. 'Once the Water

Station was inaugurated, the inhabitants of Jalimudi were thrilled,' officials of WaterMaker (India) Pvt Ltd reported. 'This is a blessing from the gods!' an elderly woman exclaimed, for she no longer had to walk for hours to collect water, had more time on her hands and kept better health. Teachers reported higher attendance by girls, who now didn't have to miss school to fetch water.

This pilot project generated a great deal of interest worldwide. WaterMakers ranging from 120 litres to over 1,000 litres are now used widely in India and several other parts of the world. They are installed in schools, factories, homes, ports, houses, community centres, medical clinics, naval bases and other places. Several companies have included these magical machines in their Corporate Social Responsibility programmes. 'We will work towards water for all,' say officials of WaterMaker (India) Pvt Ltd. They add, 'At the moment, this is not a 100% green technology because power is needed to run the machines. We hope to change that in the future and have the machines run on solar, wind, or other renewable sources. Can you imagine alternate power-producing alternate water? What a glorious thing that would be?'

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Perennial Providers

Perennial Providers

The Centre for Water Resources Development and Management (CWRDM) in Kerala undertook in-depth studies to document the existing indigenous water systems and explore ways to revive, refine and upgrade these through the support of modern science. The *Keni* (shallow wells) in one particular district, Wayanad, brought to the fore the benefits of ancient knowledge and wisdom in locating water. Even today, *Kenis* continue to serve as fountains of life.

Kerala's Wayanad District in peninsular India is in the global biodiversity hotspot of the Western Ghats. The name is an amalgamation of two words from the local dialect: *Vayal* (paddy field) and *Naad* (land) and means 'The Land of Paddy Fields.' The district has a considerable population of the Kuruma and Escherichia tribes. About 500 years ago, water harvesting and conservation structures, locally known as *Kenis*, were first constructed here. These are cylindrical, shallow mini wells. The *Keni*, which is considered sacred, serves the daily domestic and ritualistic needs of the communities that live in the area. For auspicious ceremonies such as weddings, locals always wash the rice with *Keni* water before cooking it. Dr E Joseph, Scientist, Agriculture at CWRDM, has researched extensively on *Kenis*, and confirms that there are around 200–300 still in existence.

Centuries ago, water diviners used traditional expertise to detect areas with plentiful water to construct the *Keni*. The site selection by the ancients was so precise that even a slight shift could mean the difference between striking water or not. The gushing spots were 'discovered' in wetland regions, on the edges and in the middle of paddy fields and even in the adjoining forests. Wonder of wonders! In most *Kenis*, the water levels remain the same: be it the wet monsoon, or dry summer months!

Although the water in the surrounding marshes has a propensity to be turbid because of the soil's clayey nature, the water in *Kenis* is crystal clear. This was corroborated by the physiochemical and bacteriological analyses conducted on samples. Today, with the tribe of water diviners dying out, other indicators are used to identify a site, such as clumps of trees (that attract rain) or termite mounds (as these serve as surface indicators of groundwater).

The tribal attribute the genius of the construction of *Kenis* for the miracle of pure water. In size, a *Keni* is usually 1 meter in diameter and 1–1.5 meters in depth. As these make for shallow water bodies, no rope and pulley systems or pumps are required to draw out the water. Instead, the water is collected by dipping a round utensil into the *Keni*. The side walls of *Kenis* are protected by driving in the hard, cylindrical, hollowed bottoms of tree trunks. The most popular is the rind of the basal portions of Fishtail or Toddy Palm (*Caryota urens*). The local name for these is *Panamkutty*. The trunks are seasoned by long periods of immersion in water—sometimes up to a year. This removes the inner pith, leaving the outer, hard rind for use. The rind of *Artocarpus hirsutus*, *Phyllanthus emblica* and *Hydnocarpus laurifolia* are also used. However, as these have narrower trunks, planks are cut from them to line square-shaped *Kenis*.

Nowadays, large diameter timber for lining the *Kenis* is scarce, hence concrete rings are used to line new *Kenis* and repair old structures. This, and the prevalent use of chemical fertilisers for the growing of cash crops (such as banana, ginger and areca nut), where paddy earlier grew naturally, has impacted the water quality in *Kenis*. The team at CWRDM is working on ways to resolve these issues so that the water in the *Kenis* continues to maintain its earlier purity.

Dr Joseph refers to *Kenis* as *Akshayapatra*. In Sanskrit, India's oldest language, the word means the 'inexhaustible container.' Although a typical *Keni* is roughly the same in size as a 100 litre drum, it provides over 1,000 litres of water every day, round the clock, 365 days a year. What a marvel of indigenous knowledge!

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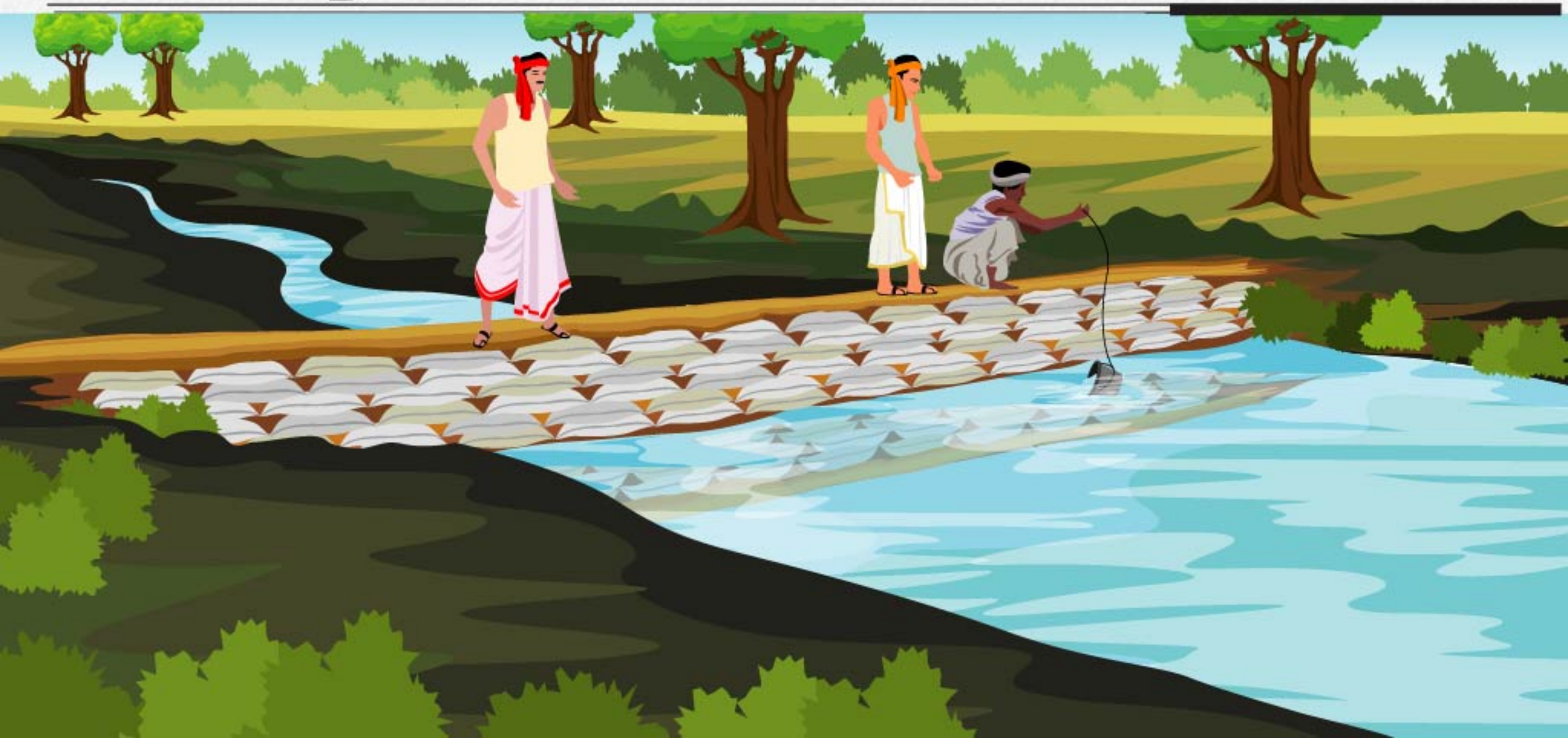
Recycled into Dams



Recycled into Dams

Khunti District of Jharkhand State is predominantly tribal. It is an area surrounded by forested-plateaus, rivers and streams. The NGO SEWA Welfare Society works in this isolated hilly terrain where only man and animal make their way.

Ajay Sharma, a journalist by profession, first came to Khunti to cover a people's agitation there. His investigations brought to the fore the contentious issue troubling the people: an acute water shortage. The locals faced income losses due to inadequate water to irrigate their fields and feed their livestock. Conditions were pathetic even for daily needs. In the village of Kuil, for example, women could take a bath just once a month! And, if the stream in your village died out, then, to reach another hill to fetch water called upon physical endurance. You had to lumber up and down the hilly terrain carrying heavy loads. Seeing all the suffering around, Ajay decided to join SEWA and do his bit to help the local community.

Ajay's research brought out something interesting. In living memory, there were hardly any campaigns for water as this was available in plenty, thanks to the magnificent streams and waterfalls that dot the land. What then had brought about this sudden deterioration? It turned out to be the indiscriminate felling of trees to clear areas for development. This, coupled with hardly any programmes to afforest the denuded areas, resulted in shaved hillsides that couldn't hold water and instead allowed it to flow rapidly down.

Retaining the water at intervals across the gradient was the call of the hour. The state government stepped in to build concrete dams on the streams and rivers, but this mission failed as the strong water currents and heavy flows during the monsoon months just swept some away. 'Once the brick-and-mortar structures were destroyed, it took months, if not years, to replace as construction was expensive. For each, the cost to build was around ₹2–3 million,' Ajay shared.

In 2018, Ajay came up with a novel concept to help ameliorate the district's water-deficient status: replacing concrete with discarded bags for the construction of the check dams. Even if these got swept away, it was no great loss, as the cost to construct was just ₹2,000 and time needed, less than a day. Bags were freely available as the cement needed for ongoing construction activity around came filled in these. Once workers emptied the material, they threw these away. He thought, why not fill these empty bags with soil or sand and arrange these to form a dam-like structure. It was worth a try, for what did it cost? Nothing. All it needed was manual labour. Ajay had an idea about a way to get this for free too.

'As the area is largely isolated, the people have learned to solve their problems themselves. The only guidance they need is a broad initial framework. Within this, the people then fill in the spaces with their own hard work,' Ajay says. So too it was with the dams constructed with bags. 'I just explained the concept to them and hoped the people would willingly provide volunteer labour for the construction,' he added. Ajay turned to traditions to ensure this. He was aware of the strong belief tof the *Adivasi* (tribal) communities in the state that upholds the value of volunteerism. Over the generations, the practice of *Madait* (help) was customary. It was natural for people of a community to combine their physical labour for a common cause, bound as they are in a sense of oneness, that stems from allegiance owed to their tribe. Once any job is accomplished, the tribals feast together.

Ajay made it a point to be present at the weekly meetings of each village *Gram Sabha* (village cabinet). This guaranteed a captive audience for him as it is mandatory for all tribals to attend the meetings. At these, Ajay

would remind the locals about the concept of *Madait* and ask that they come forward to construct the required dams on small rivers, streams and canals. 'We'll all eat together once we finish the work,' he would announce. And, it worked. He got all the labour needed to construct dams.

To construct the dams, bags are placed one on top of the other in a barrage like structure. Ajay says, 'bags filled with grass (in addition to the soil or sand) are placed in the top layer so that the grass grows and secures the bags below. This increases the strength of the dams'. In the normal course, the structure made from recycled bags is strong enough to withstand a couple of monsoons. Even if the low-cost check dams get washed away after 2–3 years, it is not a big issue as the funds are affordable and the time manageable to rebuild. The biggest check dam so far is 80 ft wide. It was completed in just three hours!

These dams constructed with bags have solved the water crisis and doubled farmers' incomes. So far, the check dams built under this initiative have benefitted about 8,000 farmers across 70 villages. There are happy faces around and peace in the district. The fear of people turning to insurgency in desperation is also no longer there. Just a few discarded bags and an innovative idea brought about the change.

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Root Zones Purify

Root Zones Purify

Myths and legends abound in the picturesque mountain state of Himachal Pradesh. Then Director Urban Development, Purnima Chauhan, was intrigued by reports of floating grass islands, believed to move magically in the sacred Rewalsar, Renuka, Khajjiarand Parashar lakes.

A visit to Rewalsar lake revealed that credit for this unusual phenomena went to phragmites (a genus of reed grass) that grow abundantly on the islands. The landmass gets propelled by the action of phragmites pulling oxygen from atmospheric air. This movement also hyper oxygenates the water to gift life to the aquatic creatures within. The linkage was proved beyond doubt when an island in Rewalsar lake was tethered to the side of the lake. The fish began dying in large numbers. Thanks to local wisdom, the island was released. As it resumed circling the lake, schools of fish thrived again.

It surprised Purnima to learn that phragmites (or *Sarkanda* as it is locally called) grew prolifically in and around the polluted water areas of the state, and is considered a natural water treatment system by locals. Could this characteristic be put to use in urban areas that have grown beyond the carrying capacity of existing water and sanitation systems? The idea of innovative eco-efficiency crystallised when she visited Barmana in Bilaspur district. Here, a local enterprise had commissioned Root Zone Waste Water Treatment (RZWT) as an innovative standalone approach to treat both grey and black water for non-potable applications, such as gardening.

RZWT is a natural biological process that has reed plants absorb oxygen from ambient air and harbour bacteria that purify the water. Biodiversity is the key to the root zone process. Effluents are passed through planted filter-beds containing gravel, sand and soil, to create an artificial wetland area. The three integrated components essential are reeds, reed beds and microbial organisms. Raw sewage is channelised down the gradient of slopes to large fields of phragmites at the bottom. The reeds get selected to match the flow rate and the nature and the expected concentration of contaminants in the wastewater. The plants absorb oxygen from the air through stomatal openings behind their leaves. These reed stems draw substantial oxygen into their hollow roots where the root zone has optimal conditions conducive to bacteria and fungi growth, making an efficient natural effluent treatment factory underground.

For the reed bed, a trench of approximately 2 ft in depth is dug as per the shape and size required to handle the wastewater quantity. This trench is then isolated from the surrounding groundwater by lining it with either clay or plastic sheets to ensure that impurities do not seep through and contaminate the groundwater. The soil is carefully selected to provide optimal conditions for both plant and bacterial growth. The system's performance depends on the full growth of the roots across the depth of the reed bed. Lastly, the over 2,000 types of bacteria and tens of thousands of fungi that exist in the reed bed oxidise impurities in the wastewater process activated underground by coexisting aerobic and anaerobic zones with different chemical reactions balancing bacterial growth. These decompose the contaminants to their basic elements to reduce phosphates, sulphur compounds, nitrogenous materials to their elemental forms. Dead plants form the humus that supports fresh growth.

An 8-hour retention of sewage in the reed bed is essential to settle and decompose the sewage water through aerobic and anaerobic action. Biological Oxygen Demand and Chemical Oxygen Demand gets brought down drastically. The outcome is treated wastewater, which is clean and environmentally acceptable. Heavy metals precipitate from the solution and get bound into the soil matrix. The nutrient-rich liquid

outflow is harvested and pumped to nourish horticulture, leaving filtered water for domestic use. The RZWT Sewage Treatment Plant can also supplement the work of old sewage water treatment plants. In Barmana, for example, the municipal capacity is an inadequate 450 m^3/day. RZSTP's additional capacity of 100 m^3/day for treating sewage generated by nearly 250 persons is greatly helpful. Many other municipalities have also created small reed beds to channelise contaminated wastewater from towns through plants of phragmites. These are constructed around overflowing septic tanks so that wastewater gets treated before it joins mountain rivers. Using nutrient-rich water runoff from the reed beds, ribbon plantations of fragrant Raat Ki Rani (*Cestrum nocturnum*) bushes and flowering Bougainvillaea (*Bougainvillea glabra*), are cultivated around the periphery of the *nallahs* (drains) before treated water flows to join other water bodies.

RZWT is indeed an attractive alternative for wastewater management. Although its initial cost is more than that to set up a brick and mortar sewage treatment plant, the running costs are low. It is chemical-free and requires no mechanical pumps. The environmental benefits are huge. All in all, it is a viable choice.

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Sparsh Ganga

Sparsh Ganga

'Sparsh Ganga' (Clean Ganga), is a campaign to help address the polluting of the River Ganga. Once pure, unfortunately, today, it is filled with garbage and effluents dumped by the millions who reside in its vicinity. Sparsh Ganga, which is a part of the mission initiated by the Government of India to clean River Ganga, focuses on the entire 2,500 km course of the river, from the river's inception at Devprayag to its delta in the Sunderbans.

Arushi Nishank leads the Sparsh Ganga campaign. She spent her childhood in a home beside a rivulet of unpolluted Ganga water in the mountainous state of Uttarakhand. Having seen this natural resource in its pristine form, she was determined to do her best to bring the mighty Ganga back to an uncontaminated state. For such a reversal to be successful, Arushi was convinced strong public support and investment were needed along with help from the government. 'People need to understand the science behind what constitutes bio-degradable items, pH factors, the effects of pollutants etc and only then will they willingly change their habits,' she says. 'Facts, statistics, why things happen often remain a mystery to the larger section of people as scientific knowledge tends to be stored in silos available to the haloed minds of the scientific community alone,' she laments. We need a viable means of communication to take the essence of complicated science and present it to the general public in a manner that draws their interest, brings about an awakening and, inspires positive action.'

'Art is a universal language to help achieve this,' says Arushi, who has the double distinction of being a renowned Indian classical dancer and a committed environmentalist. People refer to her as an 'eco-warrior' because she works to help de-pollute the Ganga for the past two decades. Arushi's love for dance helps her support her passion for rivers. She works through the power of this performing art form to reach people personally so that a deeper understanding and emotional connection is established with what is happening to our planet—in this case, the pollution of river waters. 'Art fills the gap of what scientists find difficult to do—communicate with the general public. I can vouch for its success. It helped us get our audiences thinking about changing habits,' says Arushi.

In 2016, Arushi choreographed and presented several dance recitals in the classical *Kathak* style to direct focus on the holy river. By its very name (*Katha* is the Hindu word for storytelling), this form of dance is very apt for delivering a message while holding its audience in rapt attention to its mesmerising performance. 'I have held dance shows in over 15 countries and at every one of these, the art form has served to translate complicated environmental terminologies to laypersons through appealing depictions. These are usually reserved for expert minds but also need to filter down to the grassroots level so that people understand them and are inspired to take up Acts of Green.'

The dance presentation, *Ganga Tujhe Salam* (Salute to Ganga) serves as the first step towards positive action by millions. Arushi and her team at Sparsh Ganga then work to ensure that the interest awakened in the public by the art form is buttressed with additional information and explanations on how each person can be a part of Sparsh Ganga. Similarly, the Kathak ballet *Ganga Avataran*, performed in Varanasi, Lucknow and Kanpur, won audiences' hearts and inspired people to join the Sparsh Ganga initiative. Today, Sparsh Ganga has drawn in 5,50,000 volunteers who spend their Sundays cleaning up the river's portion closest to them. *Ganga Tujhe Salam* performances in multiple countries have sparked interest in the campaign amongst the Indian diaspora there as well as others who support the Sparsh Ganga campaign with funding.

Sparsh Ganga has received wide acclaim for both the organisation and for Arushi herself. She is recognised far beyond India's borders, for example, as one of the Top 20 Global Women of Excellence 2020 in a Congressional Awards ceremony held in Chicago, under the auspices of US Congressman Danny K Davis and American Multi Ethnic Coalition. In recognition of her work, EARTHDAY.ORG named her an 'Artist for the Earth' as part of their initiative that connects with arts organisations and artists worldwide to have them engage the public on critical issues relating to the environment.

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The Absolute Water

The Absolute Water

Sometimes, just one or two individuals can effect change that benefits millions. The work of Smita Singhal and her father Sunil Singhal is one such example. The duo is the first in India to set up a working water recovery system that processes raw sewage to extract potable water. Their journey began when Smita noticed that the municipal water supply to her tap tasted foul. She sent a sample for testing; the results were alarming. Not only was the water loaded with chemicals, it even had traces of sewage in it.
The horror of this prompted the Singhals to set up Absolute Water Pvt Ltd (AWPL), recognised as India's first 100% green water recovery plant.

The system is a circular, economically viable, environmentally sound one that rids sewage water of pollutants and converts it into a life-giving resource. This self-sustained system produces no sludge, only uses readily available organic and inorganic material, and is equipped to work even in extremes of temperatures. The best part is that its source (if one could call it that) is continuously available and in large quantities as almost 62 million litres of sewage is produced daily in the country. The system recovers each precious drop from the sewage. This is a huge quantity since most sewage is 90% liquid. Imagine the litres of water recovered! Treating raw sewage reduces its leaching and percolation into the ground to contaminate waterbodies. The recovered liquid helps meet the ever-increasing demand for water in India. There is less pressure on the rapidly dwindling groundwater with this above-ground supply. And, to put it squarely, more available water reduces the hold of water supply mafias.

Sunil Singhal explains how the technology works. 'Our Water Recovery System is a non-chemical, non-RO one that retains the natural vitamin and mineral content. Statistics confirm that water recovery by this is the highest when compared with conventional systems. There is 100% recovery for non-potable applications and 85% for drinking water.
It is a green process that does not use any chemicals and produces no sludge. This eliminates the problem of sludge dewatering, handling and disposal. The requirement of energy is also very low. Often solar panels are adequate. As there is no motor, there is no noise pollution.'

'The process imitates nature,' Smita says. 'A mix of vermicast and microorganisms is used. Specially-bred worms (whom Smita refers to as 'our heroes') and a mix of bacteria work on the suspended and dissolved solids in the raw sewage and biologically degrade it to make it environmentally safe. The next step is to run it step-by-step through filtration layers provided by wood chips, pebbles and sand.
It is now good for use for agriculture and horticulture and to recharge and rejuvenate groundwater. Next, it is directed into pressurised sand and carbon filters to catch any suspended solids that might have escaped the earlier process. At this stage, it is fit for non-consumption uses such as the flushing of toilets, feeding air conditioner cooling systems and laundry.
To turn it into sparkling water that is drinkable, it is fed into specially-created membranes. The result is bacteria and pathogen-free, clear water that has no colour or odour. Even the reject discharged has uses. 'This is liquid gold of rich nutrients that have a Biological Oxygen Demand of over 10. People happily buy this far cheaper and organic alternative to chemical fertilisers', the Singhals explain.

AWPL is low maintenance, affordable and easy-to-run. Even unskilled labourers can operate it. This opens up employment opportunities for the lesser privileged members of communities that reside close to the plant. The founders' biggest hurdle was changing mindsets, for the idea of even touching what was once sewage is anathema to many. To cross this roadblock, they changed their strategy to one that brought out the financial benefits as the cost per litre of treated water

is the lowest in the country: just 8 paise per litre, less than half the cost of production using conventional systems. This helped overcome earlier inhibitions.

Their first plant, which met WHO standards, was installed at the Delhi Jal Board at Keshopur, where the huge sanitation plant for Delhi is located. This proved to be excellent to showcase the technology in real-time rather than just on paper. The plant treats over 1,00,000 litres of sewage daily. Since then, 14 additional plants have become operational—from Ladakh in the North to Hyderabad in the South. More are in the pipeline.

AWPL plants currently treat over 6 million litres of wastewater and 1.5 tons of organic waste per day. This translates into water available to over 8,00,000 people every day. The organisation regularly provides its services to institutions, industry, municipal authorities, commercial and public properties. Smita's dream to ensure that clean drinking water flows from every tap in India has already taken a quantum leap forward. With a few more AWPLs installed, it will soon become a reality.

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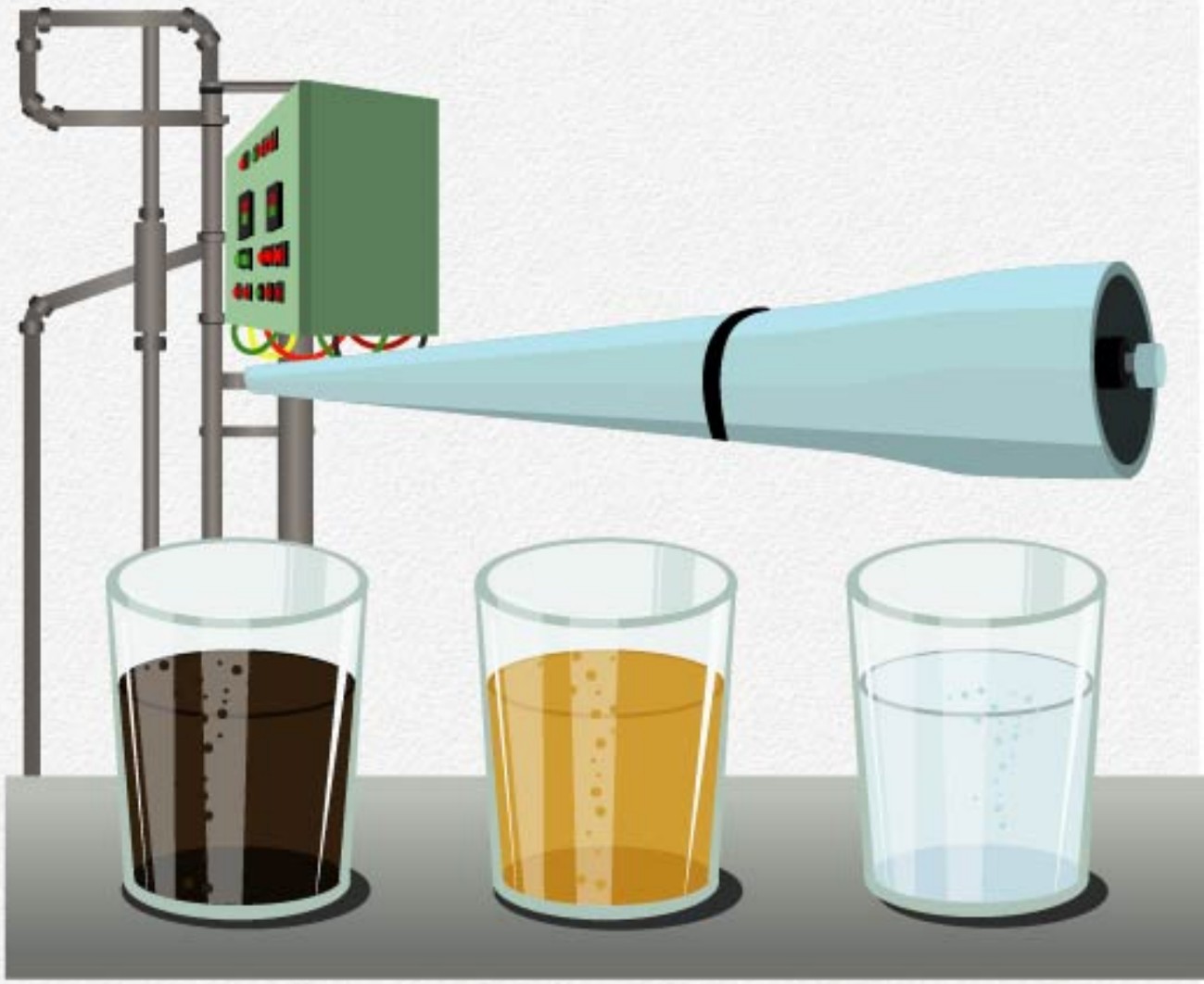

The Magic of Mist

The Magic of Mist

Taps are the most popular 'source' of water supply that millions of people turn on many times a day to help them wash, rinse, collect and store this vital natural resource. If all the water that flows out from taps was put to use, it would be one thing. Sadly, that is not the case. Just a single layer of water touches surfaces: the rest goes down the drain unused. Take the example of washing one's hands. This can waste up to 1 litre of water each time you do so. With people today washing their hands more frequently as a precaution against COVID-19, around 15 litres of water flow out of taps per person per day. So many litres wasted!

Earthfokus is an organisation set up by Arun Subramanium and Roshan Karthik. They reside in Chennai, a city where taps often run dry, so they know how important it is to find a way to save water. 'It was a Eureka moment,' Arun says, when they found a technique to help save over 95–98% of the water that flows from existing taps. 'Atomisation was the answer right before us,' he explains. 'This centuries-old process converts every drop of water into millions of droplets. As the water flow is atomised, each droplet touches the surface and only then flows downwards. The millions of droplets all emerge at the same time to create a cloud. Imagine a gentle mist in which your hands get submerged and magically all the dirt vanishes. The cleansing is done, and so much water saved too,' Arun says.

Ecomist is the name of the nozzle Earthfokus designed and manufactured to bring about the magic of saving water by turning it into mist. 'Our water-saving nozzles or aerators are attachments fixed to taps via a simple procedure. These attachments are splendid water-saving tools that help reduce close to 100% of water wastage per wash. No, we aren't exaggerating, and yes, these are the actual statistics! Water-saving nozzles can be installed in your workplace, or at home,' officials explain. Their range of water saver nozzles come with a Do-It-Yourself installation guide, making it easy to retrofit existing taps. To cater to different needs, they have a single mist nozzle that is best for commercial places where people generally just wash hands. The dual-mode water saver allows the person to choose between mist and spray modes. The shower-mode design provides an output of 2.5 litres per minute and still saves around 80% of water.

To ensure the product is durable, the nozzles are made using lead-free EcoBrass, which costs a little more, but ensures greater longevity as it is as strong as stainless steel. This alloy is also corrosion resistant to chemicals found in water.

The journey until now has had many twists and turns for Earthfokus. Arun says, 'We wanted a product that draws no complaints, so we spent hours in market-testing prototypes. Based on the feedback we received, the design was readjusted many times over to develop an ideal product. After years of going through customer feedback, we now have a process in place that makes sure only the best products are delivered to the end-user. Every nozzle that goes out from our facility is manually tested. Our specially-designed machines quicken the inspection process. Now the team can test 100 nozzles in an hour as each requires less than a minute to check. To lower the costs so that the nozzles are more affordable, we use 3D prints of the prototypes.'

Data on Earthfokus nozzles installed in homes confirm a saving of 50–60 litres of water daily with just one nozzle. Happy customers now retrofit all the existing faucets in their spaces. Commercial buildings save thousands of litres of water and energy, since pumps now run less often. There are savings in transport costs, too, as fewer tankers are required to ferry water.

'Our simple solution for an enormous problem has already been adopted by companies such as Google, Accenture and Cognizant. By 2025, we aim to help save 1 billion litres of water every day using our products,' officials of Earthfokus say. There is an urgent need to help Restore Our Earth. 'Why wash, when you can mist?' Arun asks.

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The Return of Kali

The Return of Kali

Hindus believe the River Ganga descended on Earth from Lord Shiva's locks and that those who take a dip in the sacred river every day will be emancipated from the eternal cycle of birth and death.

The story goes that a devout monk in Antwada, a forested village in Uttar Pradesh, was privileged to make the sacred ablution every day. However, this necessitated his making a small trek from his home to the riverfront. As he grew older, his feeble frame made it difficult for him to walk more than a few steps. He prayed to the gods to find a solution. Lo and behold! The next day, a stream sprung up beside his hut. This was the Kali River, referred to as *Nagin*, a word in local parlance that means serpentine. The name aptly describes the river's course of several twists and turns.

The Kali is a tributary of the Ganga. It originates from ground aquifers located in Antwada that are a mere 10 ft below the ground. From here, the flow of water begins. It gradually develops into a wide river with other streams joining it as it winds its way through several districts of the state, before it merges with the Ganga. Over 1,200 villages are located on its banks.

Over the years, people forgot the legend about the monk and the sacred river. They dumped garbage and untreated effluents into the stream, reducing it to no more than an open drain. Sugar plants, alcohol distilleries, paper mills, dairies and tanneries all discharged their effluents into it and filled it to the brim with filth. Farmers seized the opportunity to happily gain additional land by topping up the dump with soil. The freshwater was now relegated to storybooks or reminisced over by older generations. Where once there was a dancing river, there was now no trace of it. It had completely disappeared.

Nadiputra Raman Kant, a resident of Antwada village, grew up listening to stories of the river's origin. These spoke of the joy its waters once provided. Seeing the fields parched from a lack of adequate water, he wondered if there was a way to discover the Kali's source and revive the river. This was a daunting task, as what was once the water body was now dry land owned by landowners. 'And who will part with even an inch of land?' he pondered. Nevertheless, he and his team from the NGO NEER Foundation sourced old maps and historical memory to reconfirm facts that pinpointed to the river's source. They also chalked out its likely flow along a 22-km stretch to the nearest town, Meerut.

There are ten villages along this stretch. First, there was systematic outreach to their inhabitants to jog their memory of the great mythological significance of the river and evoke a sense of responsibility to make good what their ancestors might have ruined. Endless conversations, often frustrating (as the people would accuse Raman and his team of ulterior motives to grab land), sometimes tempted the team to give up. But they soldiered on. Eye-catching messages were painted on walls and a documentary produced that outlined the benefits of reviving the Kali. After five years of relentless efforts, people finally began to warm up to the idea.

Raman knew that success would only come with a collaborative effort, so NEER helped the villagers form *Nadi Raksha Samitis* (River Protection Committees). These coalesced into the Kali River Parliament. Something unheard of happened: villagers who owned land that was once the river's course voluntarily gave it up to resuscitate the river back to life. In all, 25 hectares were donated. Over 1,000 people volunteered to dig along the expected route. It took them two months to reach the river's bed.

The dugout mud (*Chikni Mitti*) was fashioned into utensils by potters and also used to fill any pits in the villages.

In November 2019, clean water sprung up. That same month, *Kalash-Pujan* (worship of a sacred pot of water) was organised in Antwada. The generosity with labour, the forsaking of agricultural land and the overall unity of effort made headlines in the country and abroad. Subsequently, senior political leaders supported development projects in the villages.

The successful revival of the river's 22-km stretch has enthused people to expand on this achievement. Similar efforts are now planned for the next 40 km. Kant says, 'I am amazed at the success and will work to ensure that the entire stretch of the Kali River is cleaned of all pollutants. Let's not forget, it drains into our sacred Ganga. Our ancestors would be most unhappy if we allowed the present state of affairs to continue. And let's be honest, the people have also benefited from more freshwater.'

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Tunnels that Give

Tunnels that Give

In Kasaragod District of Kerala State, one of the oldest tunnel systems to harvest rainwater is still prevalent. The people refer to the unique labyrinths as *Surangas*. While the origin remains a mystery, ancient Persians used similar structures known as *Qanat* or *Kariz* to irrigate hot, arid areas. In 700 BC, Mesopotamia and Babylon (cities of present-day Iraq) also had these. The Kasaragod area receives a generous 150 inches of rain annually. However, over three-quarters of this is lost as runoff. The topography in Kasaragod comprises undulating terrains of laterite hills and rocky soil that make boring wells an expensive and challenging proposition. Instead, *Surangas* (narrow horizontal tunnels, barely 2.5 ft wide and over 5.5 ft high) are dug into the hills to strike a water spring. The gravitational force extracts the underground water. It soon forms a stream that is directed to a small mud reservoir (*Madhaka*), built near the tunnel. Once the flow begins, a steady, continuous supply of freshwater is assured for years. No pumps or electric motors are required.

The construction of *Surangas* is a dying art that just a handful of people still know. To select which hill to dig requires traditional knowledge of formulae that take into consideration, the slope's gradient as well as the elevation. Other factors include the natural growth of some indigenous hydrophilic plants such as Bhoopada Mara (*Vateria indica*), Basari Mara (*Ficus virens*) and Uppalige Mara (*Macranga indica*), termite mounds and the texture of the soil. Persons who have trained aural skills can detect the flow of the water. Once the mapping is done, the procedure to construct a *Suranga* is no rocket science. A farmer can dig one himself and complete the job in a month or two. The best time to do this is once the monsoons recede (the months of October to May), as the mud around the rocks is soaked, making digging relatively easy. The system is very economical. Once dug, no funds are needed for maintenance. In addition, as the water flows out on its own, the farmer saves on energy charges compared to using a bore well. Wherever *Surangas* are functional, the farmers always have adequately irrigated fields.

In the small Kasaragod village of Kundamkuzhy lives 65-year-old C Kunjambhu, a man who has dedicated his life to provide his village's residents with a continuous supply of water, not only for drinking but also for their farms. Ambu Ettan (*Ettan,* means elder brother), as the residents call him with respect, is a professional *Suranga* digger. He strongly recommends these and explains, 'When a bore well is dug, the water comes from beneath the rocky surface of the earth, where it has collected over the years, which once drawn out, is not easy to replenish. The bore wells also start sucking water from nearby wells and ponds, draining the groundwater that links the upper crust with the rocky layer.'

It is left to veterans such as Ambu Ettan to keep the tradition of *Suranga* excavation alive. With an axe in one hand and a candle flame for light, villagers often see him doing what his ancestors taught him so well. He presses his ears to the soil and voila, he can accurately locate flowing water and even the direction of its flow. He chooses the quiet of nighttime for this, as the chances to detect even the gentlest sound of water are greater. In his 50-year career, Ambu Ettan has dug over 1,000 *Surangas*. According to Ambu Ettan, his village had about 20–25 teams of *Suranga* diggers during his early years. It saddens him that today, the numbers of people with the skill is negligible. 'Youngsters today are just not interested in taking up this traditional, bountiful system as a profession,' he says. Ambu Ettan opens up when discussing the problems digging *Surangas* bring. 'Walls can collapse during digging. There are incidents of diggers getting stuck inside the cave leading to deaths. Beyond 100 mts into the tunnel, the oxygen supply drops. Sometimes I feel suffocated as I go deeper. Some worms emerge from the soil that can make your skin itch. I have to

cover my body with kerosene to keep myself protected,' he explains. 'However, it is worth everything as the water that emerges is of the purest form thanks to the natural filtration process it passes through. You can drink it straight from the source!' he says. Ambu Ettan is very definite when he proclaims, 'I will continue my journey into the depths of the earth as long as I can.' Are others also ready to avail this remarkable technology?

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Visualising Water Narratives

Visualising Water Narratives

The search for a new water ethic, a moral compass to guide us to use, conserve, manage and 'listen' to water, has now become more significant than ever before. There is growing global recognition of the need to rethink and redesign frameworks around water with a holistic approach to sustainability. By its very nature, water is a fluid medium and its meaning in a multifaceted society like ours depends on socio-economic inequalities shaped by gender, caste, faith and class. Therefore, how we document and discuss this essential compound depends primarily on the context. It is with this in mind, that the Living Waters Museum was launched in 2017.

This virtual museum seeks to collect, curate and communicate our rich and diverse water heritage (both tangible and intangible) through a digital repository of visualised knowledge. It commemorates the past, inspires the present and is a source of learning for the future. The museum adopts a collaborative and interdisciplinary process that engages young people in 'storytelling' around water and its intersection with natural and built environments.

The Living Waters Museum results from a personal and institutional inquiry into the future and relevance of physical museums. The conceptualisation of a museum has typically been restricted to four walls, leaving little room for exploring histories and ideas in an open-ended, adaptable manner. 'If they are to remain relevant, accessible and inclusive, museums must adopt digital tools as a means of sharing knowledge interactively and in an engaging manner,' the founder says. She further explains, 'Our museum is physically based at the Centre for Heritage Management at Ahmedabad University since November 2017, but only as an office-studio space where the back-end work is developed. We've often been asked what we do that is museum-like and whether we see the contradiction in a space that is living and one that is a built-up museum. The fact of the matter is that we are building a medium to challenge the outdated concept of a museum—a building that documents and presents history. Instead, we welcome the opportunity to perceive and learn histories by critiquing them, personalising them to our experiences and freeing them from the constraints of time and context.'

The Living Waters Museum team believe that discourse around a subject such as water cannot exist without the manifestation of research into action. 'To us, that is the goal of the Living Waters Museum.' As the name suggests, water is a living and breathing entity, carrying various relationships linked to culture, faith, emotion and politics. Nevertheless, its omnipresence in our lives is seldom acknowledged. Our work recognises and illustrates these relationships while communicating the pollution and desecration caused by irresponsible practices, unplanned growth and development interventions in and around water bodies. We critically reflect on social and institutional roles towards finding equitable solutions for water sustainability, particularly those that mainstream indigenous communities and marginalised women, Dalits and Adivasi groups that are largely rendered invisible.'

This digital platform holds stories on water from across the country. The museum aims to further widen the reach to communities in every corner of the country to understand human relationships with this life-giving liquid. 'Until the onset of the COVID-19 pandemic, we executed physical outreach through storytelling and art workshops with children from diverse backgrounds, particularly those with special needs. We also hosted public events in cafés and at stepwells, exploring water's relevance through music,

film, poetry and prose. The Living Waters Museum is a founder-member of the Global Network of Water Museums, endorsed by UNESCO's Intergovernmental Hydrological Programme in 2018 as a special initiative towards Sustainable Development Goal 6. Established in Venice in 2017, the global network comprises a range of water museums that display water technologies or talk about the science of climate change, museums on waterways (UK), in open-air parks (Qatar), underwater (China) or underground (Portugal), now working together in the digital space through music and the arts to communicate our growing water challenges,' the founder says.

'Work like ours, in the digital sphere, is not exempt from challenges', the team shares. They add, 'Living Waters Museum is entirely self-funded and not-for-profit, which often results in limitations to our ambitions and ideas. However, our main focus has been on creating a network of young minds, professionals, that bring their expertise in different fields to achieve one goal—an equitable water future. Our small team is a multi-disciplinary culmination of a musician, two architect-designers, a young writer-researcher and an academic, each bringing a piece of their experience and perspective to this platform. How we function as a team is how we imagine our collective water future: inclusive, holistic, accessible and sustainable. It is the only way forward.'

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Produced by Earth Day Network, India

This ebook, produced by Earth Day Network India (doing business as EARTHDAY.ORG), is the first of a series to focus on our global theme, 'Restore Our Earth.'

We are very grateful to each and every one of the 25 contributors who shared information on their initiatives that focus on Earth's priceless natural resource—water. Our thanks also to Wysiwyg Communications, who brought the stories to life through their imaginative illustrations and refreshing design. Do visit them at www.wysiwyg.co.in.

Our previous volumes include Pathways to Green Cities: Innovative Ideas from Urban India, (Volumes I and II); Pathways to Green India: Innovative Ideas from Students and Pathways to Green India: Innovative Ideas for Public Spaces; as well as Pathways to Green India: Ways to Protect Our Species.

All of them are available free online for download or viewing.

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