Net Water Positivity in the Indian Context

A Framework for Exploring Industrial Pathways to Water Sustainability

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- The industrial sector is the second largest consumer of freshwater, most of which is sourced from rapidly-declining aquifers.
- Recognition of water-related risks and tightening regulations are pushing companies to conserve freshwater through 'within the fence' activities such as wastewater recycling.
- They are also adopting 'outside the fence' initiatives such as rainwater harvesting, however the impact is unclear.
- There is an opportunity for industries to convert water that would otherwise be destructive to a utilisable form through Flood MAR and the reuse of treated wastewater.
- To effectively drive collective action towards these large investments, we need a system of water credits that can unlock financial bottlenecks.
- Companies can offset water abstraction through water credit trading and thus reduce the demand on groundwater.

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CENTRE FOR SOCIAL & ENVIRONMENTAL INNOVATION

Executive Summary

With India's economy accelerating to become the world's third largest by 2030, there is increasing pressure on the country's natural resources. The industrial sector is the second largest contributor to India's GDP. The sector is also the second largest consumer of freshwater after agriculture.

Most of the freshwater is sourced from groundwater, which is rapidly declining. Increasing recognition of freshwater risks to business on one hand and tightening regulations on the other are spurring interest in conserving freshwater. To this end, many companies have made public commitments to ***net water positivity***.

While 'within the fence' activities such as rainwater harvesting and wastewater recycling are common, companies are realising they need to do more.

Water is a common pool resource and their own facilities can only be water secure if the resource base as a whole is secured.

Consequently, corporate water stewardship programmes have begun to extend to 'outside the fence' efforts. These are largely directed toward drinking water supply projects in neighbouring communities and watershed programs for rainwater harvesting.

The problem is the impact of such initiatives is questionable. Government spending on similar projects outstrip such efforts by an order of magnitude and quantification is fuzzy. It is not clear if any water harvested is actually reaching the aquifers the industries are tapping.

What is needed is to actually bring aquifers back into balance by increasing recharge and reducing abstraction. The question is how?

Most drier regions are already using every drop of water available. Building additional harvesting structures often just results in 'robbing Peter to pay Paul'.

We argue that there is an opportunity by converting negative water that would otherwise be destructive, to a utilisable form.

First, we make the case for ***'flood MAR'***, i.e. designing retention basins to hold excess flood water that can be tapped for recharge. Second, we make the case for investments in ***public wastewater treatment plants*** in low resource settings to improve reuse rates.

Finally, we argue that to effectively drive collective action towards these large investments we need a system of water credits.

Indian Cities and Towns are Struggling with Water

First, water stress is a problem. India has a high dependence on its groundwater resources as it caters to 65% of the freshwater demand for irrigation, 85% of the rural drinking water supply, and 50% of the urban drinking supply. As a result, extraction of groundwater has exceeded its recharge in several parts of the country, with about 23% blocks (administrative sub-divisions within districts) declared overexploited or critical (see Figure 1).

According to WWF, in urban India, 30 cities are under grave risk of water shortage by 2050, affecting 61% of India's urban population.

Second, the quality of water resources is also declining, further restricting the amount of water available for human consumption. About 70% of surface water is polluted in India. This can be attributed to limited wastewater treatment capacity that covers only 44% of the total sewage generated. Moreover, out of this available capacity, only 65% is actually operational and used for treating wastewater. Other sources of water pollution include the return flow from irrigated fields contaminated with chemical fertilisers and pesticides; and industries - one of the major contributors of toxic contaminants in water. Close to 6.2 billion litres of untreated industrial wastewater is released into the open water bodies each day across the country.

Third, an additional dimension to the water problem in India is extreme weather events, which manifests mainly as floods and droughts. Studies have found that while there has been an overall decrease in precipitation over the Indian subcontinent, patterns of distribution has changed. Record levels of rain fall over a shorter period of time, leading to high-intensity floods in different parts of the country every year. Floods in the state of Kerala in 2018 were caused by extreme rainfall that is estimated to have a return period of 500 years. The 2015 flood event in Chennai, estimated to have a return period of 100 years, overwhelmed the city's stormwater system leading to many densely-populated areas getting severely inundated.

Water Stress can Jeopardise Sustainable Water Supply to Industries

India is on a path to become the world's third largest economy with a projected GDP of USD 8.3 trillion by 2030. A growing economy means increasing demand for water resources to support this growth. However, this is increasingly jeopardised by water resources risk.

Based on a study by the Federation of Indian Chambers of Commerce and Industry (FICCI), it was projected that the freshwater demand by industries would increase from 6% in 2010 to 8.5% by 2025 and 10.1% by 2050. Given the industrial sector's high dependence, water stress poses a major risk to their operations. Moreover, industry is heavily dependent on groundwater. While reliable numbers for commercial/industrial water use do not exist, a pan-India survey of 27 major industrial sectors found that groundwater catered to 55% of freshwater demand and surface water accounted for only 51% of demand (with or without other sources in conjunction). In another study conducted by the Ashoka Trust for Research in Ecology and the Environment (ATREE), 76% of industrial freshwater demand in the city of Bengaluru was found to be fulfilled by groundwater resources.

These figures indicate that groundwater depletion puts industrial operations at risk. In an order issued on July 20, 2020, the National Green Tribunal (NGT), directed the Central Ground Water Authority (CGWA) to stop granting 'general' permission for withdrawal of groundwater by commercial entities.

The NGT clarified that 'any groundwater extraction permission should be for specific times and a specified quantity of water, and not in perpetuity.'

Before extracting groundwater in India, industries must obtain a 'no objection certificate' (NOC) from the CGWA or state authorities. The CGWA assesses an applicant's NOC request by analysing the groundwater depletion rates in the area where the applicant proposes to extract groundwater.

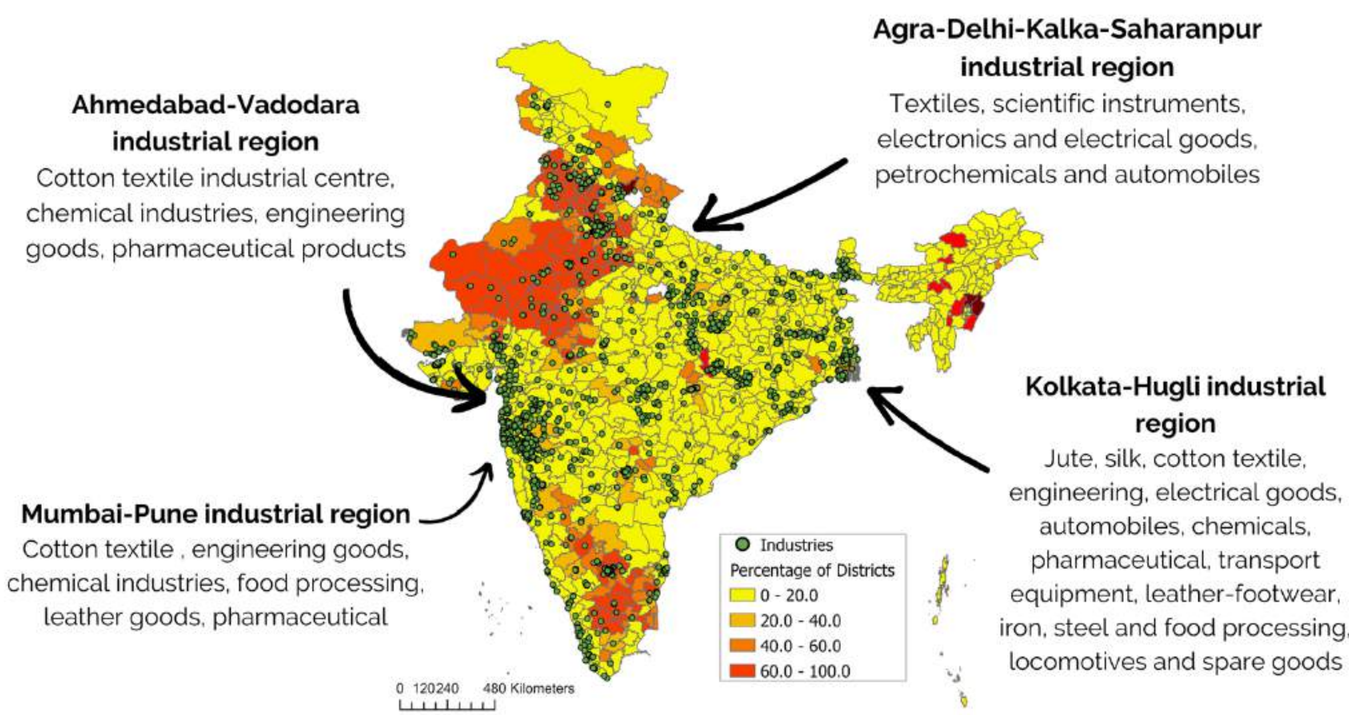
According to the CGWB, groundwater is classified into three categories based on the level of exploitation:

- ***Overexploited*** – Areas where the groundwater extraction rate is more than the recharge rate (>100%).
- ***Critical*** – Areas where groundwater extraction rate is 90-100% of the rate of recharge.
- ***Semi-critical*** – Areas with an extraction rate of 70-90% of the rate of recharge

(There are other nuanced considerations such as interconnections with surface water sources but we set those aside for the sake of simplicity.)

The map below is a depiction of groundwater stress in India's districts overlaid with major industrial clusters. Most of the industrial regions are already in areas with high levels of water stress, i.e. these regions do not have enough water to sustain operations.

Figure 1: Groundwater stress and location of industrial clusters



Percentage of a district marked overexploited or critical by the Central Ground Water Board, with yellow denoting least affected. The industrial clusters were identified using the Geofabrik dataset.

Current Efforts to Bring Aquifers Back into Balance

Corporations are addressing water-related risks through efforts both ***'within the fence'*** and ***'outside the fence'***. Within the fence encompasses water savings and rainwater harvesting efforts inside industrial premises. Outside the fence programmes typically involve watershed management projects in the immediate vicinity of where the facility is located, involving communities who live and work there. However, it is becoming clear that these efforts are insufficient. They are seldom quantified, so it is difficult to assess if they are making a significant dent in the problem.

Groundwater is a common pool resource and there is a need to bring aquifers back into balance. This is particularly important in the context of the changing climate. In low-rainfall years, agriculture and drinking water have a higher 'allocation priority' from dams, pushing most industries to rely on groundwater as a backstop.

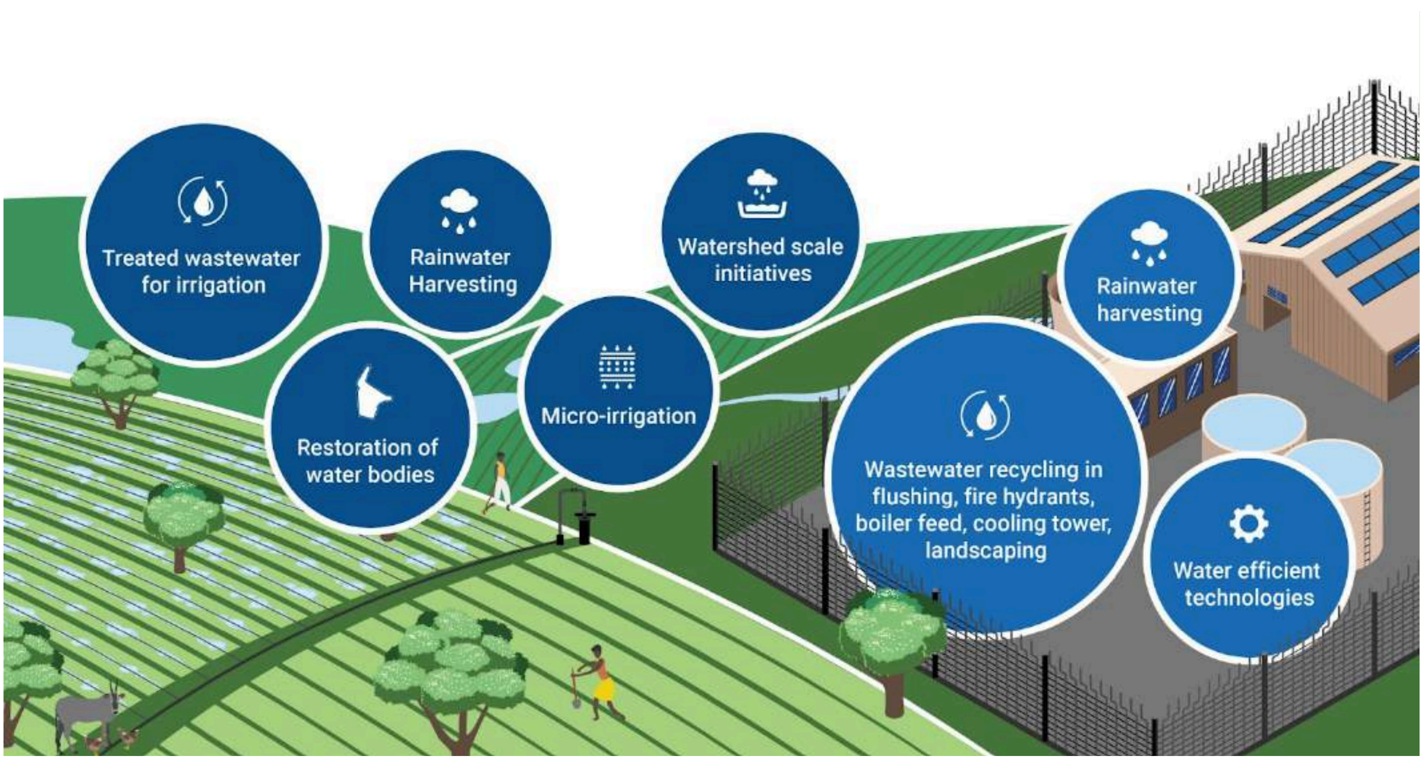
In order to bring aquifers back into balance, they must be managed better, both by boosting recharge and reducing groundwater abstraction.

The industrial landscape of India with its large budget allocations under Corporate Social Responsibility (CSR) and Environmental, Social and Governance (ESG) commitments have created an opportunity to steer water security efforts towards being ***'net water positive'***.

Simply put, when a commercial or residential development is net water positive, they are putting more water back into the environment than they are extracting from it.

The problem is that most companies in India are finding it hard to become net water positive, particularly in places where water is scarce. Currently, most industries focus on a combination of outside and inside the fence initiatives (Figure 2).

Figure 2: *Within* and *outside-the-fence* measures that most industries currently carry out



Efforts to Reduce Abstraction Have Focused on *Within the Fence*

Industries benefit directly from adopting within-the-fence measures. ***By integrating wastewater treatment and reuse, they reduce their demand for freshwater.*** This is especially important given the seasonality of water availability in India's monsoonal climate and increasing interannual variability under climate change. These conditions force many industries to become dependent on tankers that transport water from other locations, which is expensive, unreliable and affects operations.

Industries often need water for end-uses that do not require high quality water such as in boiler feeds, cooling towers, flushing, landscaping, fire hydrants and floor cleaning. These processes are easy targets for treated wastewater, as long as the wastewater conforms to basic quality standards. In addition, most industries already extensively adopt water-efficient fixtures that are deployed in different parts of the manufacturing cycle.

Another common approach is rainwater harvesting. However, industries have also been criticised for capturing a common pool resource by holding back large amounts of water within their estates at the expense of users farther downstream as well as the local ecology.

Many watersheds are 'closed watersheds' in the sense that all the available water is already being used. So, the capture of rainwater by one user could be seen as privatising a common resource.

Outside-the-Fence Initiatives Focus on Improving Recharge and Reducing Abstraction.

Outside-the-fence initiatives include watershed interventions, rainwater harvesting, micro-irrigation and restoration of water bodies. In India, recent amendments to the Companies Act mandated publicly-listed companies to spend 2% of their three-year average annual net profit on CSR activities every financial year.

Many of these initiatives explicitly focus on helping companies become 'net water positive' – if not across their supply chains, then at least across their facilities. But these initiatives are often problematic and have attracted criticism for being, at best, ineffective and, at worst, 'bluewashing'. We illustrate these challenges with two examples:

1. Water harvesting structures

Many water harvesting structures were built as a part of watershed development programmes across the country, which encompass a wide range of activities such as the construction of check dams and desilting of village ponds and tanks. These measures were meant to help conserve soil moisture, improve land productivity, and thus boost farmers' incomes.

However, there are two challenges with investing in such programmes:

- ***It is unclear whether these projects are able to bring aquifers into balance.***

The focus on soil and moisture conservation often does not extend beyond the topsoil. Moreover, rising groundwater tables induce further intensification. There is also a more fundamental problem of quantification. It is not clear whether these efforts are contributing to aquifers becoming net water positive.

- ***The additionality of these programmes is not always clear.***

India's central government has been implementing watershed development programmes since the 1980s, and their efforts have been augmented by philanthropic institutions and civil society organisations (CSO). There has been considerable investments in constructing physical infrastructure, mostly water harvesting structures. If industries also invested in these, there may be no additionality here. Given CSR budgets are small compared to large government schemes, the question is whether such efforts could yield any benefit.

2. Drinking water projects

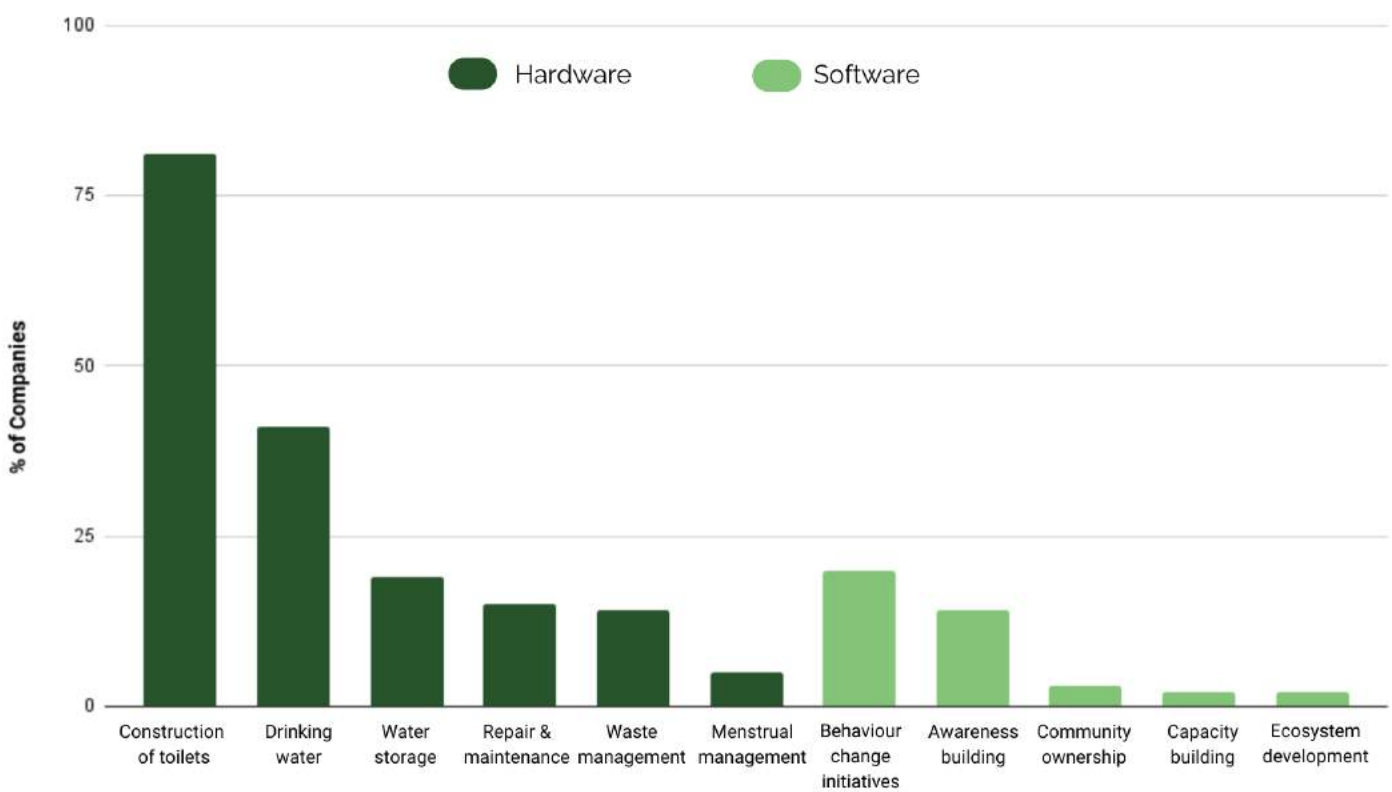
Companies invest in water-related initiatives mostly in the WASH sector (water, sanitation and hygiene), which requires them to work with the local Public Health Engineering Department (PHED) or the Rural Water Supply and Sanitation Department (RWSSD).

But these investments in WASH are often focused on 'hardware', i.e. creation of physical infrastructure and not 'software', like capacity building and training (Figure 3).

This skewed interest in engineering outputs could potentially render the whole programme a failure. For instance, in constructing toilets and setting up RO plants to provide drinking water, the challenging part will be ensuring that there is water supply to sustain usage. Much of the current infrastructure is not being used as there is not enough water. This creates 'slippage', i.e. communities slip back into inadequate or unsafe water or sanitation practices.

Another reason for slippage is that the resource base itself is depleted. Unless this is sustained, further investment in new or deeper borewells is futile.

Figure 3: Intervention-specific distribution of CSR in WASH programmes

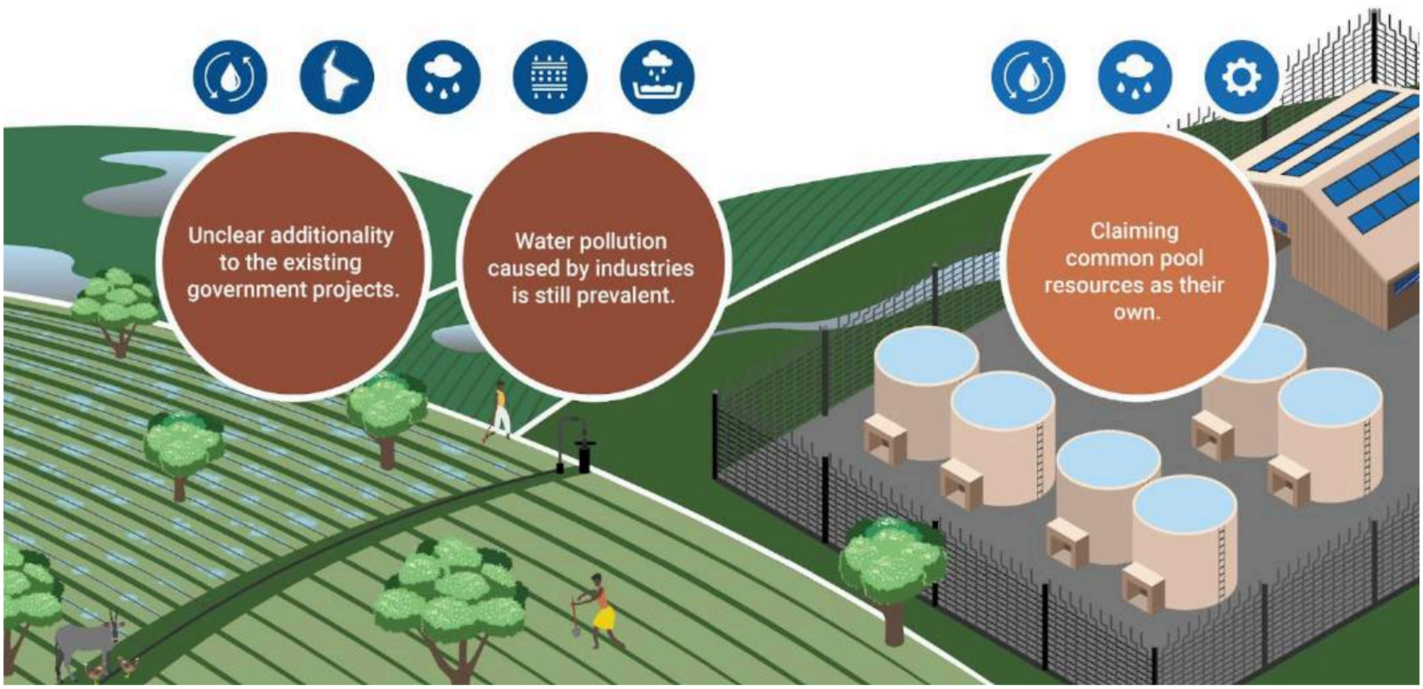


Source: Samhita, CSR in WASH. What are India's top companies up to?

Apart from creating unusable physical infrastructure, these are often wasteful from an energy perspective as well. A lot of money is spent on electricity for pumping water from great depths and for the RO treatment itself. But many plants do not adequately account for maintenance; hence, the long-term financial sustainability of these RO plants is thrown into doubt. Many become defunct when the maintenance contracts expire.

Finally, there is the challenge of equity. If communities have to pay for drinking water, it is often the poorest that get excluded and suffer.

Figure 4: Limitations of current efforts to reduce water abstraction



Solutions for Outside the Fence

Industries aiming for net water positive impact need to actually address the bigger water challenges. There are limited opportunities to find 'new water'.

One way to find 'new water' is to redirect water that is currently damaging to both the environment and the economy, flood water and untreated wastewater.

We propose two solutions to approach water conservation and recharge that involve converting such 'negative' water to 'new' water:

Flood Managed Aquifer Recharge (MAR)

With climate change, India's water resources are plagued by both floods and droughts. This inequitable distribution across space and time is also an opportunity to find 'new water', if flood waters could be tapped. Most rainwater harvesting structures have limited storage capacity, so they capture the first portion of the hydrograph but not the peak (Figure 5). As a result, the majority of high flow runoff in a flood event that is destructive in nature cannot be captured and a large volume of flood water remains untapped.

Flood MAR or spate irrigation has existed traditionally in arid and semi-arid regions, predominantly in parts of Africa and the Middle-East.

Large quantities of flood runoff coming from high slopes are diverted using natural or man-made channels towards bunded fields or for groundwater recharge.

These methods work at a watershed scale where the water conveying structures have a high capacity to capture and divert a large volume of flood water. The term Flood MAR was coined by the Department of Water Resources, California. Modern forms of flood water diversion structures aim to improve the efficiency of water collection, while at the same time reducing sediment inflow in the channel.

In the hard rock aquifer systems of peninsular India, recharge into borewells may occur very slowly.

Therefore, the key to Flood MAR is creating space to temporarily store flood water on land that can be used for other purposes for the rest of the year.

The measures usually take the form of large-scale interventions where sufficient land is set aside as a retention basin to accommodate the incoming surface runoff.

Benefits from flood water harvesting include increased water availability, improved habitats, higher ecosystem value and higher climate resilience. From being excessively depleted and contaminated, the state of aquifers considerably improves. With higher water levels in the aquifers, the baseflow in rivers increases through groundwater and surface water interaction. Land subsidence can also be restricted with improved water availability.

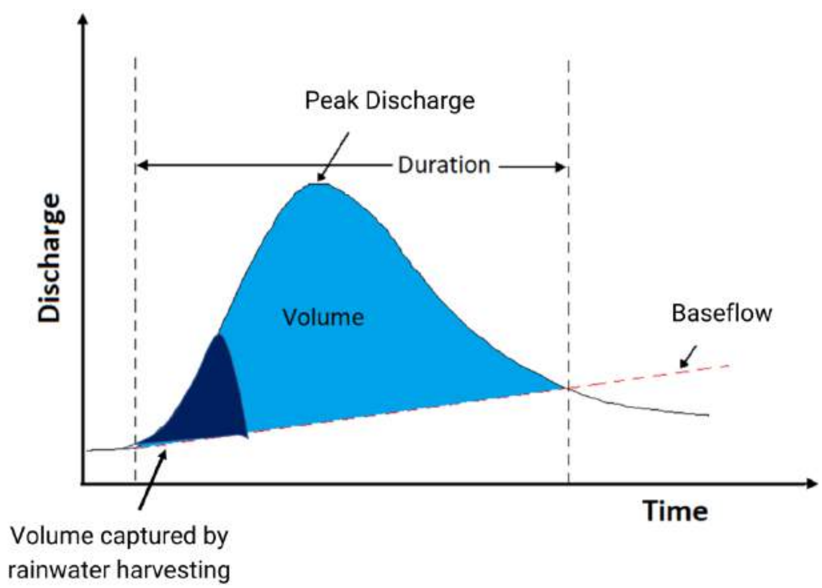
Further, the seasonal flow of flood water rejuvenates floodplain habitats improving the ecosystem of the region. All these benefits contribute towards better climate resilience by creating a buffer against drastic changes in temperature and precipitation.

What is the Difference Between Flood MAR and Rainwater Harvesting?

The key difference between flood water harvesting and rainwater harvesting lies in the intensity of surface runoff captured by the system.

Conventionally, it is difficult to capture high-intensity rainfall because of the limited soil capacity for infiltrating water. Once saturated, soil begins to act like a sealed surface generating large volumes of surface runoff leading to an event like a flash flood. Therefore, to enhance groundwater recharge, retention structures and retention storage in the form of floodplains, open spaces, farm fields or wastelands are important to make flood water harvesting possible. The storage design of retention basins is governed by two factors - the quantum of water generated based on the flood return period in a region and the rate of infiltration in the soil.

Figure 5: Rainwater harvesting vs. Flood MAR



The dark blue denotes the water that can be captured through rainwater harvesting structures, which have limited storage capacity. They capture the first portion of the hydrograph but not the peak. There is a case for Flood MAR because of the quantum of water it could potentially capture, store and replenish aquifers with.

Investment in Public Sewage Treatment Plants

The second opportunity lies in enabling safe reuse of treated wastewater - either for recharge or to displace freshwater abstraction.

The Central Pollution Control Board (CPCB) in 2018 identified 351 polluted river stretches in India in nearly all states and Union Territories (UT). These states and UTs have to submit their action plans to bring these rivers back into compliance with ambient quality standards, and the local bodies in charge will be liable to pay compensation of Rs. 5 lakhs a month per drain if the order was not implemented on time.

According to the latest CPCB report, the National Inventory of Sewage Treatment Plants 2021, treatment capacity is not even half the total sewage generated in the country. A huge amount of sewage is left untreated or partially treated and is discharged directly into rivers, polluting them. This further increases stress on the remaining freshwater resources.

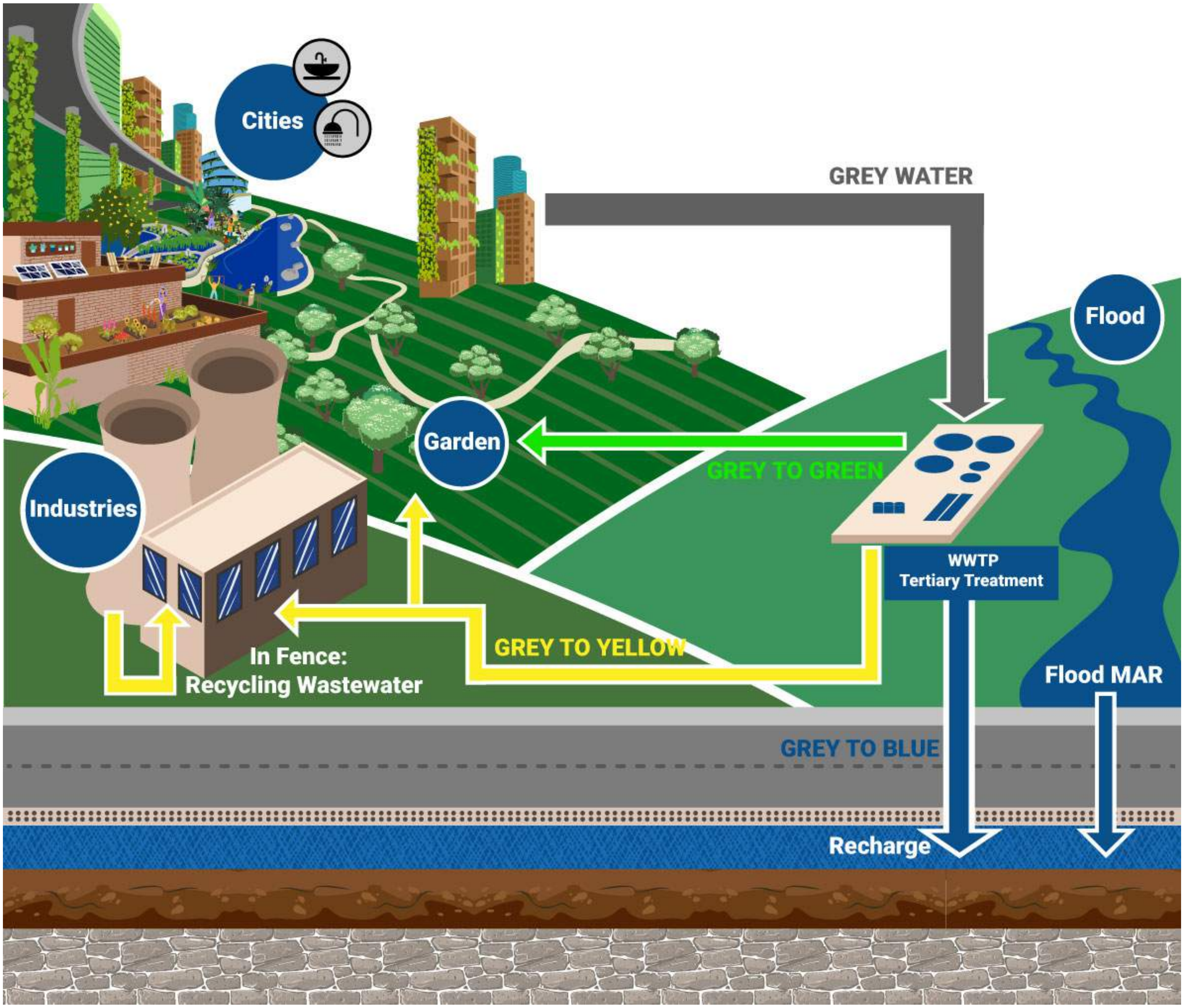
The challenge is that most Indian cities barely charge for water, which means wastewater treatment is not recoverable through user tariffs. As a result, the only recourse that is available is through courts.

In other words, there are no carrots, only sticks, in our regulatory toolbox.

In the absence of recoveries from user charges, poorer states strain their meagre resources to pay the fines and install STPs. There is, however, an opportunity to involve corporate water stewardship programmes in treating wastewater to a quality that would enable reuse. The programmes would cover the amortised cost of building and operating STPs for a period of 10 years.

The difference between such a programme and the actual purchase of wastewater is that this allows companies to pay for an STP and create 'new water' at a location that is not near their site – far beyond their fence. Also, they do not necessarily have to consume all the treated wastewater themselves. Since the quantum of freshwater generated this way is measurable, it should also allay fears of bluewashing.

Figure 6: Water treatment and Flood MAR to bring aquifers back into balance



Building the Ecosystem for These Solutions

Water Credits for Collective Action

What we need to achieve in the next few years is get industries to see water offsets in a similar way that they see carbon offsets.

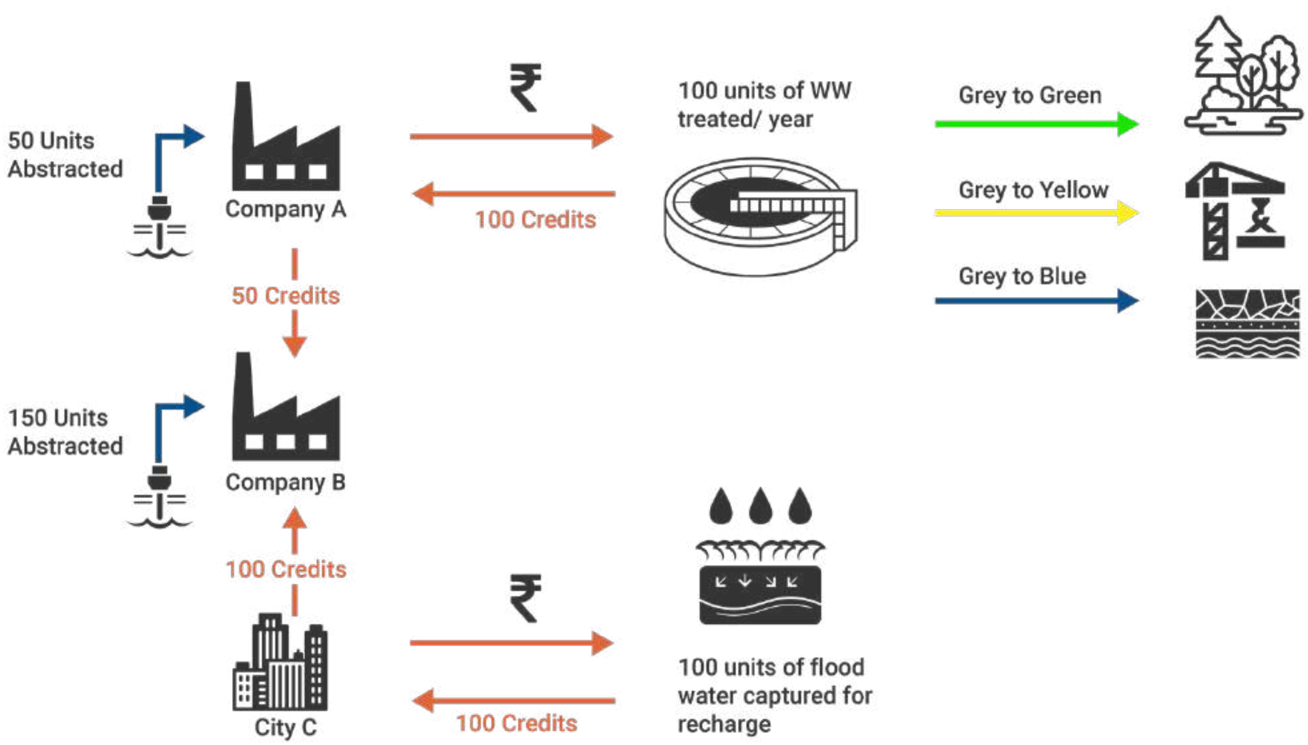
Industries are interested in quantifying their efforts in abstracting less water and putting back more water into rivers and aquifers. As water is a highly localised resource, its conservation within the same watershed as that of abstraction is important, especially if the watershed is water-stressed.

Because financing is a critical bottleneck that prevents solution adoption, we can imagine a water credit system that facilitates financing and encourages capture of flood water/wastewater.

The industries located in a watershed can invest in public infrastructure – Flood MAR or sewage treatment plants – in exchange for water credits.

They can use these to offset abstraction or sell to another company. A water credits system may encourage higher investments for wastewater treatment. This will in turn enable higher reuse by industries and other stakeholders, while checking groundwater over-abstraction and surface water overuse..

Figure 7: A water credit system to achieve net water positivity



Enabling Wastewater Reuse

How do we ensure that wastewater that gets treated to requisite standards actually gets reused?

Within a landscape, there are many users - each with different water quality requirements.

Mapping appropriate demand with the right water quality can lead to freshwater savings, economic savings and preservation of natural water bodies from pollution.

Grey to Yellow: *For non-potable use in industry, infrastructure and construction*

The Grey to Yellow concept is a part of the larger wastewater circular economy. To achieve this on the technical front, it is necessary to first map opportunities based on treated water quality generated by a private or municipal STP with potential buyers within the industrial ecosystem. Innovative financial instruments could allow the exchange of treated wastewater - one such instrument of water credits has been discussed above.

Grey to Green: *For urban landscaping and greening*

The Grey to Green concept involves using treated wastewater generated from domestic use for urban gardening, watering parks and medians. This water with high organic content is suitable for urban gardening. Further, public scepticism and utility disagreement is the lowest in terms of this form of reuse as the water is not in contact with humans.

Grey to Blue: *For replenishing groundwater aquifers*

The Grey to Blue concept is the conversion of treated wastewater into groundwater recharge. Also called Managed Aquifer Recharge, which we have used in this document to refer to flood water, this method leads to mixing of treated wastewater with natural groundwater recharge through rainfall. Two programmes exist in Western Australia and Singapore that utilise MAR to offset the resource of desalinated water to meet drinking water demand. These programmes are the Groundwater Replenishment Scheme (Western Australia) and NEWater Scheme (Singapore). For both, a three-step advanced water treatment process in addition to basic wastewater treatment is set up, including microfiltration and nanofiltration, reverse osmosis and ultraviolet disinfection. This is to make sure that the water can be used for drinking purposes and does not contaminate natural water aquifers.

The Way Forward

To enable systemic-level changes to incorporate these strategies, we need regulations, technology, financing and institutional capacity and coordination as well as participation from the communities.. This requires active participation of a wide range of stakeholders and coordination between different implementing agencies as well as communities that are affected. However, all of these enabling factors are preceded by technical clarity on the implications and effectiveness of the measures to ensure judicious use of financial resources as well as the available capacity.

In this section, we discuss the potential impediments associated with implementing Flood MAR and recycling of treated wastewater to highlight challenges that need to be addressed for adopting solutions at scale.

<table>
<tr><th></th><th>Flood Managed Aquifer Recharge</th><th>Grey to Yellow</th><th>Grey to Green</th><th>Grey to Blue</th></tr>
<tr><td>Technical</td><td>Hydrogeological characteristics: Accounting for unique typology of aquifers to ensure effectiveness of measures.
Potential recharge: Understanding the changing rate of rainfall and extreme events for enabling recharge.
Ecological implications downstream: Accounting for a potential conflict between the water needed for the downstream ecosystem and upstream diversion of rainwater.</td><td colspan="3">Infrastructure setup: Lack of uniformity in infrastructure requirements between different users.
Lack of technical capacity to retrofit existing systems</td></tr>
<tr><td>Regulatory</td><td>Water quality standards for groundwater recharge are absent: To ensure safety as well as ecological integrity of fresh groundwater resources, it is necessary to have a set of water quality standards.</td><td colspan="3">Lack of regulatory framework to direct the use of treated wastewater: Missing water quality standards hinder the use of treated wastewater. Lack of clarity on the process of obtaining permissions for enabling local-scale reuse.</td></tr>
<tr><td>Economic</td><td>Conflicting land use: Allocating already constrained space for capturing fast runoff at the cost of other income generating forms of landuse</td><td>Additional cost of tertiary treatment
Freshwater suppliers fear loss of income</td><td>Changing demand makes infrastructural setup uneconomical
Seasonal fluctuation of water demand for landscaping might discourage transporters of wastewater</td><td>Additional cost of tertiary treatment</td></tr>
<tr><td>Governance</td><td>Lack of coordination between stakeholders
Public perception and participation: Identify beneficiaries of the programme to enable development of financing mechanisms.
Lack of knowledge-transfer mechanisms: Best case practices often remain confined to local knowledge.</td><td colspan="3">Lack of coordination between stakeholders
Public perception: Treated wastewater reuse is largely governed by the acceptability among potential users. Therefore, establishing trust on water quality is a key enabler.</td></tr>
</table>

If you are a private corporation interested in understanding more about how you can become a net water positive company or create 'new water', please reach out to us:
csei.collab@atree.org

We are keen to understand your needs better and collaborate with you.

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