Arghyam: A Praxis on Regenerating a Groundwater Civilisation

Abstract

Arghyam, which started as a funding organisation, has evolved into being an influential voice in the water ecosystem. In the present (2022), it works with a network of organisations on water security solutions across the country. Through exploring Arghyam's shifts in its strategic approach, the case study engages with the challenges of dealing with the complexity of the water sector in India and what it takes for philanthropy to sustain commitment to a singular cause. Arghyam's most recent pivot commenced in 2018, when it decided to focus on supporting strategic levers of scale that could significantly benefit from digital technology use. This pivot was based on its past experience but nonetheless required realignment within the organisation with new modes of engagement, enhanced operational capabilities and talent requirements. While Arghyam recognises the need for strengthening scalable solutions, organisationally it continues to remain compact and lean. This case study shows that the most complex of problems do not necessarily demand the biggest of organisational resources: it requires thoughtful and timely deployment of limited resources. This demands a level of intentionality and strategic agility that can test the mettle of any organisation, least of all a philanthropic one.

Keywords: Strategic Philanthropy; Water Sector; Groundwater; Participatory Groundwater Management; Praxis; Common-pool Resource; Public Digital Good

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> As with oil, water exploitation raises an inter-generational debt that will be hard to repay. The uncontrolled and rapacious exploitation of oil has led to unintended consequences, and if we continue on a similar trajectory with water, the oil crisis will seem like the trailer of some horrible disaster movie. (Rohini Nilekani, Founder, Arghyam, 2007)

An accidental entrepreneur and philanthropist

The year was 1981, and a young Rohini Nilekani was working as a journalist with the Bombay Magazine. She had just gotten married to Nandan Nilekani, an engineering graduate she had met four years earlier at a quiz competition in her college, Elphinstone in Mumbai. Nandan, NR Narayanamurthy, and a group of five fellow engineers were working on the idea of a software venture, and looking for funds to start up. Rohini, partly from her savings, and partly borrowed from her parents, invested Rs. 10,000 in the venture. It was launched as Infosys, today one among India's most-reputed public corporations.

The success of Infosys changed the life of the Nilekanis dramatically, and they came to be one of the wealthiest families in India. Rohini's own early investment in the company grew substantially. Coming from a middle-class background, however, the newfound wealth was an uncomfortable experience for Rohini to adjust to, as she reflects:

> Since Infosys became so phenomenally successful, I became wealthy alongside Nandan as well as independently of him. Nandan often says, "I am an accidental entrepreneur." Similarly, I then became an accidental philanthropist. It took me a while to get used to this kind of wealth, coming from the background that I did. I was always left-leaning on the political spectrum, so I was a little suspicious of the wealthy as I grew up. It took me a while to get used to my own wealth, but then I realised that wealth can be an opportunity to achieve the goals that I had always dreamt of. I always wanted to live in a society that looked out for its weakest members and realised that wealth could be one vector to make that happen. (Parekh, 2019)

Seeking intentionality in philanthropy

With Infosys growing rapidly, Nandan's travel requirements were increasing. In 1992, Rohini quit her full-time job to raise their two children. This period of her life introduced her to two lifelong passions—philanthropy and writing. Her first venture into the world of philanthropy was with an organisation called Nagrik, working on road safety. Her experience with Nagrik led her to develop a deeper understanding of structured, strategic philanthropy. She recalls that:

> For me, the power of intent always mattered a lot. I did realise on the way, however, that just the power of intent is by no means enough. When I co-created my first institution in 1992, Nagrik, we wanted to have safer roads in India. While the intent was strong, by every metric it [Nagrik] was a disaster; now I realise that we didn't yet have the language or the grammar of that intent so that we could be effective… However, what it did do is teach me that just passion and unstructured use of time is not going to make any change possible. Knowing what I do today, I would do Nagrik very differently. But that's how we learn–by failing. (Nilekani, 2022)

Rohini's philanthropy was further distinguished by a drive to strengthen civil society institutions and leadership. Civil society is at times referred to in developmental studies as the "third sector" of society—after the State and markets. However, for Rohini, it was consciously the "first sector," one that must acquire a solid foundation to enable society to bind better to solve problems of the age and restrain the excesses of the State and markets. This was an early point of departure that over time came to characterise her personal approach to philanthropy. She further shares:

> I think what holds my entire philanthropic portfolio together is one simple idea, which I hope is also a powerful one, and that is that, in the continuum of (civil) society, state and markets, my entire focus is on strengthening (civil) society, or as we call it here [in India], *Samaaj*. Because I truly believe that markets and the state have to be responsive to (civil) society, and to make the state and market accountable to the largest public interest, we need a very strong leadership and institutions of society to make that happen, and to collect and co-ordinate ordinary people's efforts so that they become and remain part of the solution, rather than become victims of the problem itself. So, whether I'm working in environment, in water, in education, in arts and culture, it's all about finding institutions, individuals and ideas that strengthen *Samaaj* or (civil) society. So that's the very common thread, and the rest of it is just based on my passion and opportunities for many different things. (The Business of Philanthropy with Badr Jafar, 2021)

Arghyam: finding a praxis

It was subsequent to her experiences with Nagrik that Rohini set up the public charitable foundation Arghyam in 2001, as a vehicle for her to learn and engage with philanthropy in a more personal way. In its earliest days, before water became its focus, Arghyam made several small grants to a variety of causes. She recalls that one of the grants which brought the team the most satisfaction was made in support of the Paediatric Intensive Care Unit at Manipal Hospital in Bengaluru (Arghyam, 2021).

Between 2003 and 2004, the sale of Infosys shares from her early stake in the company yielded Rs. 100 crores, an amount which she decided to put, in its entirety, into the newly founded Arghyam. Reflecting on this period, she shares:

> Now, 100 crores doesn't sound like much when you think of philanthropy, but at that time it was a sizable amount, and I had to figure out how to use it strategically. Believe me, it is not easy to give money and give well. We started researching. I hired a CEO, Sunita Nadhamuni, and we said, what shall we work on that will make a difference to the people of this country in a small way? Because we knew we were going to be small. And actually, we were looking at health issues, and several other things. (Columbia Global Centers, 2018)

In the midst of scanning through issues and sectors it was rather by chance that Rohini's attention turned to water. Her curiosity and course of inquiry into water resulted in a period of intensive research along with new CEO Sunita, on the status of water in India. This led the newly-formed team to realise there was no dedicated Indian philanthropic organisation working in the space of water; and that a wide-spread water crisis was unfolding that was all the more marked by its absence from the developmental discourse at the time.

Though still young, Arghyam realised the best way to learn was to get into action early. It therefore started by making several small learning grants and holding wide-ranging conversations with those involved in water around the country (Arghyam, 2021). This mode of experimentation, engagement, learning and strategising seeded in its younger days continued to characterise Arghyam even as it matured. But perhaps it was the very nature of the subject of water it had chosen as its undertaking that firmly cemented this praxis: water in India lends itself to no easy understanding. While its science is objective, its social meaning is highly subjective and context-laden. The young Arghyam was intentionally wading into a challenging area.

Building a perspective behind the praxis: water in India

India is home to 17% of the world's population, but only accounts for 4% of its freshwater resources (Gupta, 2022). Freshwater arrives annually as precipitation in the form of rainfall and snowfall. However, this precipitation is not uniform around the country. Thus, Arunachal Pradesh received 2,993 mm of total rainfall in 2020, whereas Rajasthan received 24 mm (Ministry of Earth Sciences, 2021). Further, the majority of this annual precipitation—70%—occurs across just three months of monsoon (Bhardwaj, 2022). Not all the precipitation received is held onto: the intensity of precipitation over a short period of time contributes to flooding of land surface and large amounts of water that hits the surface quickly drains away into oceans through rivers. Including the effects of evaporation, only around 51.5% of the total precipitation remains as natural runoff: the yearly flow through India's system of river basins. Finally, due to topographic and geological variations, less than a third of the annually received precipitation (29%) is "utilisable" (PIB Delhi, 2022).

This utilisable water—the precipitation that remains—serves as a source of replenishing India's invisible water banks: its groundwater aquifer systems, which are as intricate and fascinating as its visible river system. However, again, the soil absorbs less than half (38.7%) of the utilisable water (PIB Delhi, 2022) where it replenishes underground aquifers. The rest remains on the surface in a variety of forms, including rivers, lakes and ponds, and constitutes the total utilisable surface water (refer to Exhibit 1).

Together, the aquifers and the surface water sources, provide the basis for meeting water needs of a growing economy and population. However, neither the precipitation, nor unfortunately, the utilisable water, has kept pace with this growth (refer to Exhibit 2). There are many competing demands on water: the agricultural sector is by far the biggest user of freshwater resources in India, accounting for 91% of all freshwater use. Domestic usage makes up 7%, while industrial use accounts for the remaining 2% (Rao, 2018).

Surface water is not sufficient to meet this demand for food production and other agri-commodities. Despite being home to multiple large river systems (refer to Exhibit 3), nearly 62% of cultivable land, the basis of India's agrarian economy, depends on groundwater. Similarly, on the domestic side, the contribution of groundwater is still higher especially when it comes to drinking. 85% of rural drinking water supply, and 50% of urban supply is sustained by groundwater (Central Ground Water Board, 2020). The invisible nature of groundwater, though, makes it difficult to alert us to the degree of our reliance on it, as well as to properly manage available resources. Over time, this has lent itself to a narrative of poor governance, over-extraction and exploitation of this particular aspect of freshwater.

"A groundwater civilisation"

> India has spent hundreds of thousands of crores on surface water, by creating command areas, dams, et cetera. But that money has under-performed so badly because India is actually a groundwater civilisation. We have been an open well civilisation, and after the borewells came, we started digging deep into the earth for water. (Rohini Nilekani, INKTalks, 2017)

Groundwater is contained between layers of rock and soil beneath the earth's surface. When usable amounts of water are held in layers of water-bearing rocks, and accessible through wells or natural springs, the region is called an aquifer (refer to Exhibit 4).

Aquifers, and the natural springs and manmade wells they feed, have been of utmost importance to Indian society all the way back to the earliest recorded permanent settlement in the subcontinent. India's historic relationship with groundwater dates back to the Indus Valley Civilisation (or Harappan civilisation) which existed in the area drained by the Indus and Saraswati rivers between 4,000-6,000 BCE (Mark, 2020). At its peak period, one of the largest settlements of the civilisation–Mohenjo-Daro–is estimated to have had nearly 700 aquifer- fed wells (Singh et. al, 2020). These wells, and the areas around them were often considered sacred and critical to the prosperity of the region. The wells themselves were often elegant and ornate structures. Refer to Exhibit 5 for an overview of the number and types of wells in India over time.

The Green Revolution

The 1960s, which marked the onset of the Green Revolution around the world, saw a rapid rise in agricultural productivity through the introduction of chemical fertilisers, pesticides, and high-yielding varieties of seeds. In India, the advancements of the Green Revolution embarked the country on the road to acquiring food self-sufficiency and becoming a major exporter of food grains. The revolution was accompanied by an increase in the area under cultivation, and in turn, the net area under irrigation in India. The relative difficulty of canal irrigation (especially as the distance of cultivated land from a surface water body increased) compared to the ease of drilling wells to tap into underground aquifers, invariably resulted in a surge in groundwater consumption (Mukherji, 2020). With time came the development of better drilling and pumping technologies, further aiding the ease of tapping into the ubiquitously-present aquifers. Refer to Exhibit 6, which shows the trends in area under food production and the area irrigated by groundwater sources.

Surfacing a crisis

As Rohini highlights, despite its ubiquitous nature, the chief characteristic which sets groundwater apart from surface water, and results in an entirely different set of challenges with regards to both understanding and managing this important resource, is its invisibility:

> While all water is eventually connected, groundwater, unlike surface water, is nearly ubiquitous. It is replenishable, it is almost free and it can be pulled out as needed, without spending on overground storage systems. This makes it a perfect resource for lifeline use, for farming, and for any other demand. Yet groundwater is also invisible and capricious. It can fool you into believing there is an infinite *Patalganga* flowing beneath your feet. Depending on which of the many hydrogeological zones of India you tap into, the water can either be easy to reach or incredibly difficult to suck out…This invisible and capricious nature of groundwater has resulted in so much exploitation and overuse that we now have a very visible and consistent crisis.
> …
> [There are] 35 million borewells spread around the country, and while we are building the irrigation infrastructure for surface water and talking about rivers, people are drawing up water from the ground…so we have to make that invisible water visible, use good science, use good data and use society's own ability to innovate to help us manage our groundwater better. (Nilekani, 2018; Columbia Global Centers, 2018)

A consequence of depleting groundwater levels but ever increasing demand driven by population growth, economic growth and agricultural output is that India is the world's largest abstractor of groundwater: contributing to nearly a quarter of annual global abstraction of this resource. India's annual groundwater consumption exceeds that of the USA and China—the world's first and second-largest economies by GDP—combined (Jovial, 2022).

Over-extraction eventually results in bore-wells that have to be dug ever deeper to reach aquifers. Technological developments have ensured that modern drilling and pumping technologies have kept pace: they are now advanced enough to enable a 1,000 ft borewell to be dug within a week. In Bengaluru (refer to Exhibit 7) for instance, where shallow aquifers could once be tapped at a depth of 200 ft below the surface, borewell depths have reached 1,900 ft in a bid to maintain water security amidst surging demand (Thakur, 2020). This rush to reach and consume the aquifers, storehouses of an indispensable, critical civilisation resource, reminds of another parallel: the voracious consumption and rapid depletion of fossil fuels to the point of scarcity in the short span of a little over a century.

This streak of consumption conclusively leaves behind its costs. For farmers, the cost of drilling more as well as deeper wells to irrigate crops can result in unsustainable debts piling up. A single borewell can cost upwards of Rs. 30,000 depending on the depth to be drilled, and drilling equipment and motors can cost up to Rs. 1 lakh (Agrotex Global, 2021). In a country of small-holder farmers, rain-fall-dependent agriculture and periodic agri-distress, failure to find water on a drilling attempt can spell desperation and disaster for an individual farmer.

In one documented case in Pulammadi village, Ranga Reddy district, Telangana, following a third consecutive season of drought, villagers dug 190 borewells at depths of 160 to 700 ft within the span of two months between February and March, 2016. The total cost to the farmers of the village was Rs. 1.3 crores. Less than 20 of these wells yielded water, and those that yielded water dried up within two to three weeks. Distress and debt caused by borewell failure have been one of the biggest reasons for farmer suicides in Telangana (Sudhir, 2016).

Central Ground Water Board (CGWB) is the national apex agency concerned with the management, exploration, monitoring, assessment and regulation of India's groundwater resources (refer to Exhibit 8). In its most recent assessment carried out in 2020, it found groundwater aquifers in 21% of 6,965 assessment units (locations) around the country to be in the category of "Critical," "Overexploited," or "Saline" (no longer functional). A further 15% were in a "semi-critical" state (Central Ground Water Board, 2020).

The legal conundrum: private ownership? public trust? common-pool resource?

While nature and users of water determine much about its trajectory, water also exists front and centre in the public domain. Its use by one has bearing on others. Hence, its governance from community to the State affects its future as much as any other factor. Its governance, like in case of any shared resource, is best encapsulated in the language of policy and law.

This language has to address conflicts between users and stakeholder groups, fairness of use and examine them through the lens of inter-generational considerations. Adding to the puzzle is the fact that this language is crafted in laws made at different times to serve differing interests, and that these laws themselves might be in conflict with each other.

However, under-cutting it all is finding the balance between the meaning of private ownership of water and of water as a public good, a dilemma that animates not just water, but many other socially critical resources in any political economy, especially one as large and diverse as India. In the case of an intimate and life-sustaining resource such as water the law acquires a special resonance. As a donor trying to build a perspective for its praxis on water, what the right perspective on governance should be demanded much attention, as Rohini highlights:

> In rural and peri-urban areas, heightened competition for the same, finite groundwater is leading to open conflict with industry and urban settlements. In urban India, inadequate, inefficient and inequitable municipal supply has resulted in a race to the bottom to draw groundwater of any quality from any locality at any price…For one, land and water rights are entwined in India through common law, and also because some colonial-era laws remain unchallenged. There are other laws that constrain this right, so it is not an insurmountable obstacle. Yet the question, "Does everyone have the right to extract the water under his or her property?" has not been fully answered yet.
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> If the answer is yes, then it becomes a free-for-all. If the answer is no, then technically, no one can draw water from nearby springs or wells without permission or licence of some sort. (Nilekani, 2018)

One of the legal antecedents—an old British-era law known as the Easement Act, 1882—has governed the relationship between landowners and the water beneath their land for over a century. In essence, ownership of land meant ownership of any water underneath. Thus, a private landowner had unrestricted access to dig as many borewells at any depth on their land, extracting unlimited, free water, to use in industry, agriculture or domestically. An entire aquifer, passing underneath several tracts of land owned by several different individuals, can legally be drained by a single person able to tap the aquifer (Columbia Global Centers, 2018). Refer to Fig. 2 of Exhibit 4 for a visual representation of the implications of the Act.

The draft National Water Framework Bill, 2016, attempted to correct the implications of the Easement Act, which, as written, accentuates inequity of access to water by giving unlimited licence to withdraw water to landowners. The correction was based on the view of water as a Public Trust[1], whereby the State, at all levels, holds natural resources in trust for the public, thus putting in place a legal mechanism to ensure that no single person's use of water can affect access for others (Shah, 2018).

Rohini continues:

> Indeed, whether water should be treated as a public good held in trust by the state or whether it is to be recognised as a common-pool resource managed by communities through social protocols is at the very heart of the debate on groundwater futures. While this uncertainty remains, the very nature of groundwater makes it possible to access it anywhere, anytime, provided people have the capital. And so, this common-pool resource becomes a de facto private good, or

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[1] "Public trust doctrine is a legal principle establishing that certain natural and cultural resources are preserved for public use. Natural resources held in trust can include navigable waters, wildlife, or land. The public is considered the owner of the resources, and the government protects and maintains these resources for the public's use. The doctrine is most frequently used in the context of water bodies. Throughout the United States, most lakes and streams are maintained under the public trust doctrine, typically for the purposes of drinking and recreational activities. The public trust doctrine also prevents private property from extending to the ocean." (public trust doctrine, n.d.)

> an open access resource. Private over-extraction and unrecognised, unregulated groundwater markets are already creating havoc in the countryside. Currently, no proper regime exists to control this trend.
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> …
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> But perhaps the most vexing structural issue is the invisibility of the aquifer. Water from rivers, streams, or even from dug wells, gives continuous visible clues about availability. But with deep aquifers, it is difficult to assess boundaries, storability and yield. What cannot be seen is even harder to manage. So, everyone dips into the same finite pool without even knowing it. (Nilekani, 2018).

Beyond State: civil society and water

Understandably, this multi-layered nature of water governance in India means that large-scale efforts in the governance and management of water remain a State subject (refer to Exhibit 9). Individual state governments in particular have firm voices in the governance of water resources within their borders. However, governance of water also cuts across multiple central government ministries and departments. For instance: the Ministry of Jal Shakti (river development, drinking water supply and sanitation); the Ministry of Agriculture (irrigation development); the Ministry of Environment, Forest and Climate Change (monitoring water quality of natural bodies); and the Ministry of Power and the Ministry of New and Renewable Energy (hydropower development). Rohini underscores:

> The state is often interested in "big water"—building large irrigation canals and hydropower projects, with little scope for nonprofit involvement and collaboration with society. To add to the complexity, while education falls under a single government ministry, water cuts across 17 ministries or departments and comes under the purview of around 20 budget heads. (CAPS, 2021)

At the level of communities and local governments, civil society participation (i.e: concerted action by concerned citizens for collective benefit) in water resource management traces its roots beyond and independently to those of modern State policy or legal thought. One of the earliest examples of community-led participatory management of water is the centuries-old practice of "*Kudimaramath*," from Tamil Nadu, where communities would supply the time and labour to build and maintain small-scale ponds and tanks for drinking water and irrigation (Rajendran, 2018).

In Maharashtra, groups of farmers would build canal systems moving through land owned by several cultivators, diverting river flow on a small scale for irrigation. The network of canals was managed by a committee of farmers and irrigators with an elected chairman, while water distribution through the canal system was handled by community members who also contributed to its maintenance. There are records of this system (known as the *Phad* system) in north-western Maharashtra as far back as the 16th century. It is still present in several districts of the state today (Bhaduri, 2013).

In more recent times, in the modern Indian State, many of these once-prevalent practices have disappeared, and the organisation of civil society effort in the water space has taken the form of non-governmental organisations (NGOs), academic bodies and community-based organisations. These contribute to water governance under the dominant framework of respective individual state water policies, but also through field-level research, project design, advocating rights-based approaches and facilitating access for communities to legal provisions on water-related concerns (Ahmed et al., 2019).

Participatory approaches to water-resource management, most alike the traditional efforts at water management, have also seen a revival since the 1970s. For instance, the Pani Panchayat system started in 1972, or Anna Hazare's model of watershed management started in 1975 (Arghyam, 2015). Refer to Exhibit 10 for a brief sample of community-based participatory approaches for water resource management in India.

It was against this complex context that a young Arghyam was trying to find the form for its praxis in 2005. It chose to involve itself outside of the State apparatus, or in Rohini's words, with "small water": water security as it related to the domestic lives of people and communities; along with the water-and-sanitation nexus which affected squarely the quality of water. Water as it related to large-scale industry, energy, and agriculture, for example, would not fall under its scope of work. Following through on its in-depth, intensive research into the groundwater crisis in India, Arghyam also made the choice to focus its efforts specifically on nurturing groundwater rather than surface water security in communities.

First steps in the water sector

Arghyam's current CEO, Jayamala Subramaniam (who took over the role in 2012 when Sunita Nadhamuni–its CEO from 2005–moved on), describes the seven to eight years of Arghyam's life following 2005, as primarily being about intelligence-gathering—understanding where the issues were, how communities and other organisations were dealing with water issues in their contexts, and identifying potential partners (civil society organisations) to fund.

Over these seven years, it became clear to Arghyam that as a philanthropic actor the problem it was looking to solve was at once both "hyperlocal" (in terms of the complexity of local communities' relationship with water, local climatic, hydrogeological, agricultural, forestry and horticulture patterns), and present on a very large scale around the country (in terms of the number of communities and locations where resources were needed).

At the same time, Arghyam was acutely aware that it did not yet have the critical degree of knowledge and expertise on its own to be able to play a more directive role. Instead, there was a strong acknowledgement of its partners' existing understanding of the groundwater problems in their respective areas, and of solutions that had already been developed. Over this initial seven to eight year period, its funding to partners was not linked to specific approaches or types of solutions. Arghyam assessed funding proposals and engaged partners in areas of work where, based on the data and intelligence it had been gathering, the partner could have the greatest impact. In this phase the organisation was, in Jayamala's words, "solution-agnostic."

Gradually, Arghyam came to be the only domestic philanthropic organisation focussed exclusively on water. The added emphasis on community-based groundwater projects further sharpened its profile. With time, a role beyond that of purely providing funding resources started opening up; in particular, it was able to play a facilitating role, bringing together a variety of actors and supporting them in enriching their own solutioning efforts. Jayamala recollects that this facilitation moved beyond actors on the ground and it was able to join voices on policy with government bodies as well as with other funders on how resources on water should be directed around the country.

Sunita Nadhamuni (CEO until 2012) later came to recollect that this broadening of Arghyam's efforts started to yield a sense of a developmental ecosystem around groundwater challenges and concerns:

> Our NGO partners told us they found value in the role Arghyam played in creating platforms for connecting organisations, sharing best practices, enriching models, and amplifying their advocacy efforts. We also found that it was important to leverage our role as donor to provide risk capital to unconventional and bold experiments. (Arghyam, 2021)

Facilitation beyond the field

Its diversity of partners and its facilitator instinct helped Arghyam arrive at a more rounded view on the subject of water: it understood the space of interventions on the ground, and it developed its own sense of policy and legal questions that encircled water. This expansive perspective on water naturally grew its canvas of facilitative actions. In 2007, Arghyam launched the first of its two flagship programmes: India Water Portal (IWP), a web-based knowledge portal for the water sector. The initiative used digital technology to increase availability of know-how related to water practices.

The programme was in response to a push by the National Knowledge Commission[2] (NKC) to create web-based national-level portals for key sectors such as water, energy, teachers, environment, and biodiversity. According to NKC, "The portals would serve as a single window for information on the given sector for all stakeholders and would be managed by a consortium of representatives from a wide range of stakeholders to ensure they have a national character." (National Knowledge Commission, 2007).

Arghyam offered to set up and fund the portal for water, which came to be called India Water Portal. Working papers, research reports, news articles, data, events and discussions on water were made accessible over IWP. The English language version of the portal, Rohini shares, was primarily of interest to India's community of researchers. The Hindi-language version of the water portal, however, found great uptake amongst citizens, and was able to help many take up "ideological battles on water." (Columbia Global Centers, 2018).

In one incident, a major cement-producing corporation in India had its licence to operate limestone mines in Chhattisgarh revoked after IWP published a report on pollution and depletion of groundwater supplies in the surrounding villages. Print media followed up on the report, visiting the area for a more detailed investigation. The corporation's mining activity was found to be polluting groundwater available for irrigation and livestock, and the corporation was found to have not followed up on contractual promises to provide employment, health and education in the area. There have been several further instances where articles and stories appearing on IWP have led to citizens approaching government authorities to get local problems resolved (Chhabra, 2017).

India Water Portal was recorded as receiving more than 6,500 daily visitors to its English-language site, and 10,700 daily visitors to the Hindi version (2017). According to Jayamala, the portal had a catalytic effect in bringing to public attention stories of water scarcity and overexploitation of groundwater supplies. India Water Portal continues to be used to date (2022) by stakeholders in the sector, and the wider public (Chhabra, 2017). India Water Portal was amongst the first programmatic examples of a pattern of thinking that would with time come to define its praxis: an ability to quickly grasp different strands and take bold steps to tie them together in thought and action.

This strategic independence and agility was pronounced in an area perhaps singular to Arghyam's water foray: its increasingly intense conviction on emphasising the restoration and revitalisation of the "small water," "groundwater civilisation." Behind this conviction lay Arghyam's resolution of the legal conundrum of water in its own mind: that groundwater was a common-pool resource (refer to Exhibit 11). Resolution of this conundrum mattered, for it gave Arghyam a settled foundation to accelerate and amplify its future actions.

[2] The National Knowledge Commission (NKC) was a high-level advisory body to the Prime Minister of India (then Dr. Manmohan Singh), with the objective of transforming India into a knowledge society. National Knowledge Commission (NKC) was constituted on 13th June 2005 with a time-frame of three years, from 2nd October 2005 to 2nd October 2008. The NKC was given a mandate to guide policy and direct reforms, focusing on certain key areas such as education, science and technology and e-governance. Easy access to knowledge, creation and preservation of knowledge systems, dissemination of knowledge and better knowledge services were core concerns of the commission. (Knowledge Commission, 2021)

A common-pool resource perspective

A perspective of water as a common-pool resource naturally raises questions such as: How much gets used? Who uses it? Who provides it (through tube wells, borewells etc)? For Arghyam to facilitate the ecosystem of groundwater management at grassroots, it also had to answer these questions and take steps towards developing a normative for groundwater management which kept common-pool resource principles at heart (Arghyam, 2015). It also forced Arghyam to take a close look at the connections that lay at the intersection of practice, policy and law; or, to explore the connections between *Samaj, Sarkaar and Bazaar*. It was a rich and complex intervention space that Arghyam, as a funder-facilitator, was moving into.

These questions did not invite easy answers but by now, Arghyam had grown comfortable when confronting complexities. With IWP it had learnt to bring together (facilitate) minds to let an intervention space take form. The common-pool perspective of groundwater served as the impetus for Arghyam to design and launch a landmark program in 2011, called Participatory Groundwater Management (PGWM), as an attempt to answer these questions. Rohini lays out the foundation of PGWM:

> When groundwater is a common-pool resource, you have to create participatory mechanisms to manage it sustainably. Otherwise, partly because we have no recognition, partly because we have no institutional structures to manage groundwater, there is no alternative [but depletion]. In the absence of good policy and regulation, we have to push through the community and make a sort of de facto, if not du jour, model way of managing groundwater. So, participation was a very key, philosophical core and why it's called the participatory groundwater management programme. (Columbia Global Centers, 2018)

PGWM: Encompassing the local and the national

A few years before its formal launch in 2011, the first phase of the project's design involved articulating the key principles of a participatory approach to groundwater, and generating buy-in from actors in the water sector ecosystem. These principles were established at round-table discussions and brainstorming sessions of groundwater experts convened by Arghyam— both from its project partners and those from other major groundwater projects in India at the time, such as the World Bank-funded Andhra Pradesh Farmer Managed Groundwater Systems Project (APFAMGS/ APWELLS) project.

The project itself would be developed by "PGWM Resource Centres"—four prominent Indian institutions working on groundwater: Advanced Centre for Water Resources Development and Management (ACWADAM), Arid Communities and Technologies (ACT), People's Science Institute (PSI), Watershed Support Services and Activities Network (WASSAN) (Rangan, 2016). Refer to Exhibit 12 of this case for a summary of these institutions. PGWM was piloted by the Resource Centres at different sites in four key hydrogeological contexts of India (e.g: mountain systems, volcanic systems, alluvial systems, sedimentary systems). Refer to Exhibit 13 for a visual representation of these settings around the country.

The PGWM programme was built upon three key pillars: action research, capacity building and advocacy. Action research was field-based research done to understand the specific groundwater-related concern of a particular location, so as to develop a contextually appropriate pilot programme to address the issue. It involved identifying project sites based on community needs, geological mapping, collection of baseline hydrogeological data and socio-economic surveys. Following this, capacity for ongoing management of the resource was built in local communities through collaboration and partnership. Protocols for sustainable and equitable utilisation of groundwater resources were developed with ownership by community members; youth from the local areas were trained as para-hydrogeologists; and core scientific principles and technical knowledge related to groundwater management—such as aquifer mapping—

imparted as part of the training. The third element, advocacy, aimed to influence decision-making and promote good practices with regards to groundwater management and participatory approaches at a local, state and national level (Arghyam, 2015).

The PGWM programme became instrumental in knowledge-generation for issues related to groundwater, combining modern science and traditional community knowledge. With the success of PGWM's design came opportunities for Arghyam of increased participation in the policy space. The intervention's design was recommended in the 12th Planning Commission as a key program for aquifer mapping in India (Arghyam, 2015). Additionally, the proposed reconfiguration of the Central Ground Water Board (CGWB) was to include within it a Participatory Groundwater Management Division (Shah, 2018), which would lead the implementation of the *Atal Bhujal Yojana* (launched in 2019): a Rs. 6,000 crore central government scheme aimed at improving groundwater management through community participation (refer to Exhibit 14).

Taking stock: A sombre realisation

By all accounts, PGWM was an intervention of some heft and extracted a lot out of Arghyam to see it through; but it also came to distil and symbolise all that Arghyam had learnt through its own journey of action-reflection. Rohini reflects on the PGWM programme's impact in 2018, seven years after its launch in 2011:

> We have directly funded about 500 installations, in the sense that our hydrogeologists, experts and others go into these communities where there is a problem, they help those communities to make the invisible water beneath their feet visible by using data, data practices and good science. And then train people to understand and budget for their water. There are many mechanisms that people use: they segregate some borewells for lifeline water so at least that is taken care of; they do crop rotation or better crop management. It takes time, there are no shortcuts in this, but after two years, the community realises that by sharing that finite resource under their feet, incomes go up…So, we are very encouraged with this and we've done a lot of input into policy. (Columbia Global Centers, 2018)

At the end of 2018, through PGWM and its other projects, Arghyam had supported over 100 partner organisations on 140 projects, disbursing more than Rs. 155 crores. Their projects—to facilitate the implementation of solutions to water scarcity and security around the country—had directly or indirectly reached around 74.9 lakh people (Arghyam, 2019).

However, despite the steady progress on ground and influence on policy, this period was also one of an uncomfortable realisation and subsequent soul-searching. Ironically, PGWM, which simultaneously operated in multiple spaces—at the level of community, local institutions and broader policy—also brought into sharper focus the disconcertingly hyperlocal character of groundwater management.

Hyperlocality in "small water"

This hyperlocality foremost placed demands on time of all concerned stakeholders. PGWM required prolonged and in-depth knowledge exchange between communities and facilitators: not only to arrive at a common understanding of intervention strategy, design and outcomes, but also to communicate the highly technical aspects of groundwater such as hydrogeology and geological mapping.

It further meant that ongoing support for such interventions also had to account for the creation of local governance and institutional mechanisms to achieve the intervention's long-term objectives (refer to

Exhibit 11). For the participatory protocols of PGWM to become the norm with regards to the way a community related to their groundwater resources required a shift within the community to a common-pool resource view. In the context of the landless or marginalised sections of communities, this was an especially significant aspect, requiring sustained civil society engagement. Along with navigating local social dynamics, building this deeper understanding of the resource and its equitable use within a population required ongoing conversations with multiple stakeholders, and a convergence of various local institutions charged with groundwater governance (Rangan, 2016).

Put together, the demands on time and the understated but critical role of community governance stretched the limits of a philanthropic organisation like Arghyam. Getting involved in long-term governance for each and every one of 500 locations with a PGWM installation was simply not feasible given Arghyam's own resource base, nor did it fall within the organisation's core scope of work.

Jayamala, reflecting on these learnings, shares that:

> So, for [communities] to understand their situation, quickly see what to do about it—and then do it—builds the kind of at-scale resilience that we want. Because for anybody else who is sitting far away, to understand the signals and then to respond takes the longest time, and by then the situation is out of hand. So, we saw that [aspect] working very, very well. But we saw that the models themselves were very "thick": they took too long, and it was too expensive. And when we looked at how we now do this for the rest of the country—we probably did [PGWM] in 1,000 villages over seven years—we said this model is completely untenable. It's not going to work.

In spite of the success of PGWM, this "thickness" made Arghyam review its own role: a role that would have to fully accept the hyperlocality of small water, yet find ways to leverage the resources Arghyam had to the fullest.

Pivot to mission-mode

The past successes did not sit comfortably alongside the intent to scale. The acute sense of the scale and breadth of the groundwater crisis made scaling seem both desirable and logical; but from where it stood, this required Arghyam to move from supporting programmes to sustaining a mission. PGWM—despite its impact and potential—was still conceptualised and funded as a programme. Scale, on the other hand, required a degree of standardisation which a programme sensitive to "hyperlocality" may not be able to offer.

It was a difficult paradox to fathom: the success of a powerful idea led to self-introspection rather than rejoicing. But perhaps it was not such a surprise after all given the fact that despite its focus and success in water so far, Arghyam's was a small set-up of 17 full-time staff. The intensity to continue to contribute to water meant that Arghyam would always grapple with the question: how could it extract and lever the best mileage for the resources it had given the severity of the issue at hand? Especially, as it knew that even after nearly 20 years of its own work, water was yet not part of mainstream philanthropy.

In 2018 the team at Arghyam initiated a deep dive into the latest emerging issues in the water sector and according to Rohini, the exercise aimed to clarify some key questions for themselves:

> How could we contribute better? How could we be even more strategic, better leveraged? How could we create transformational impact over time instead of the steady but incremental progress we were making? What could we do which had not been tried before? (Arghyam, 2021)

Arghyam's partner organisations were also consulted in this process, and as Jayamala notes, they relayed a shared concern:

> In fact, we went to our partners and asked them, 'What do you think you want to do? 10 years from now, do you want to do five more villages? Or do you want to do 500 more?' And they themselves said, 'It's a problem. We want to scale. We don't know how." So, it's not just our team—it's actually the partners who told us that they have this problem.

Internally, Arghyam's small team of 17 was split into smaller groups and asked to come up with their own answers: should the organisation change its approach or not? And if so, what should the new approach be?

The teams returned after several weeks and laid bare their options. These were subject to a voting process and a few key shifts were decided upon. Finally, three themes stood out: leveraging digital technologies as a means to scale, tuning up the intensity of its engagement with the government, and having a definite point of view on the types of solutions most likely to scale. Echoing these changes, Jayamala explains:

> So, we said, if our mission is to impact many, many more people, then we need to look at something else that will amplify this. And that's when we said, if digital is being used to amplify so many things, can we understand how digital can be used to amplify this [Arghyam's work in PGWM]? And that's what we've been doing over the last three years (since 2018): to see how digital can be used to empower communities, for them to then manage their water much better. So therefore, our mission is to enable actors—water actors—for them to then reach water security for 100 million people by 2023.
>
> To put this in context, we probably reached about 5 million people in the previous seven to ten years. So, that's the kind of jump we want to do in much less time. We are not saying we want to do this because we think that we are arrogant enough to take this on. But we are saying the problem requires this kind of response, and if we don't respond at the scale of the problem, then we all become irrelevant.

Resisting irrelevance: Arghyam 4.0

> The result of the weeks-long exercise, in consultation with many partners, led us to what we call Arghyam 4.0[3]. We decided that we would try to build public digital goods, as tech-based infrastructure for the water sector. There has been far too little use of information technology in the service of water security. In the digital age, with near ubiquitous access to mobile phones, we believed there was an opportunity to democratise knowledge and skill-building for *samaaj*, *bazaar*, and *sarkaar*. For citizens, the state and water practitioners too. (Rohini Nilekani, Arghyam, 2021)

This pivot towards digital technology defines Arghyam's current approach. Previously, its support already covered multiple domains of technology: the scientific and technical aspect of its work

[3] Broadly, Arghyam's phases since its inception were: Arghyam 1.0- set up in 2001, not yet focused on water; Arghyam 2.0- A water-exclusive philanthropic organisation, from 2005 onwards; Arghyam 3.0- 2007 up until around 2018, launching flagship programs like India Water Portal and Participatory Groundwater Management; Arghyam 4.0- 2018 to present (2022).

(hydrogeology, agroforestry, horticulture, etc.), and information technology for data analytics and management of its network of partners. However, Arghyam 4.0 was not just a greater emphasis on the digital but a change in the way of thinking about digital technology: as a means to facilitate and embed a common-pool resource view in the management and governance of a hyperlocal small water arena (refer to Exhibit 15).

With 4.0, Arghyam was looking to articulate and commit to a new digital normative for the water sector: a “data commons” giving all in the sector access to open-source data. How to architect (including establishing the highly complex technical design of such a commons) and bring this about would test the capability of Arghyam. But all together, this shift was about to once again demand much from Arghyam, much as its shift to a facilitative role and then to PGWM had done in its earlier days.

While stretching the limits of technology application to water was novel, the new strategy also tried to equally emphasise a more traditional thought intrinsic to development work: the role of the government. The recognition was that the government held vast funding resources and the infrastructure to move funding around. If Arghyam was not able to influence the flow of funds at government level, they would not be able to achieve the scale they were thinking of.

Exercising selectivity

It was also the first time Arghyam was explicit that it had a stance. Initially, as a new entrant to the space, its focus was on intelligence-gathering and supporting the implementation efforts of its partner organisation while remaining neutral to the types of solutions its partners had chosen to implement. With time, it was also able to facilitate discourse between water sector organisations. The design and launch of Participatory Groundwater Management (2011) was the first reconfiguration of its role and identity. But starting in 2018, it clearly preferred to support certain types of solutions. Jayamala reflects:

> Earlier, we didn't really have too strong a point of view. It was okay for us to say we are neutral, because we were not experts. But for what we are doing now, there was no benchmark. There were technology organisations, and there were water organisations. But there weren't any organisations that were tying the two up. So, we realised that if we don't have a strong point of view, we may not be able to make much progress, we will just continue to keep talking. So, I think we had to change our DNA quite a bit, to actually develop the ability, the capability, the skill sets, to synthesise, arrive at a point of view and then articulate it. I think we had to do that as a team.

It also found itself in a situation where it was now a reference organisation for the sector, with actors in the sector starting to look to Arghyam to provide direction. The team decided that progress towards its strategic objective would be hampered by not being able to provide one.

Adoption of a stance influenced the partners and projects it brought on board. Considerations of scale, amenability to digital technology, and community ownership and participation dictated these choices. Jayamala was candid on the challenge of taking Arghyam’s new approach to its partner organisations:

> Everybody accepts that there is a fundamental systemic problem. I don't think anybody disagrees. What they may disagree with is that we don't know what to do. And since we don't know what to do, we go back to doing it the old way.
>
> [With practitioners] they often can't leave that one ship which is kind of sailing and move to something else, which they don't know what it is. So, they continue on that ship. And they're waiting for somebody to say, “Show me some other pathway because I'm already on my way here. You show me some other way and I’ll jump.”

> That is how it is. And a lot of people [Arghyam's partners] jumped early on. We needed that, and they did. They said "Okay, we'll try this, we'll see." And we told ourselves that this can either be magical or it will be a spectacular failure.

The difficulties were not confined to its work with its partners. Jayamala notes that the leadership expected that the period would prove difficult for those working inside too. Indeed, during this time, several staff members did leave Arghyam. However, she highlights that it was the team themselves—including those who left—who came up with, voted for and defended against scrutiny the new plan. Some staff members left as they were unable to align with the organisation's new strategic direction. Others left because for the first time, Arghyam was openly taking a stance on what type of solutions would be funded. Jayamala explains that:

> It was difficult from both a philosophical point of view, as well as a capability point of view. There were people who said, they didn't quite think they were wanting to be part of this. They didn't want to be part of a [funding] organisation that had a point of view, because they said, "As a funder, you are better off not having a point of view"—and a funder is what we were. So, some of them left. The others who felt like they wanted to make the change, and believed that they could do it, stayed on. I think today we have reached a point where I would say we have changed and morphed 90%. The new people who came in, of course, came into this kind of philosophy and capability. So, we hired for this. But the older ones who stayed back have morphed to build these capabilities.

The pivot within: people, priorities, and, processes for change

Arghyam nonetheless marched on for it had pegged itself to a milestone of reaching 100 million people in just a span of five years. It quickly busied itself with providing capacity building for water practitioners, government bodies and frontline field workers in the use of digital technologies for groundwater management; understanding and selecting the most appropriate technologies from a variety of options; and bringing together disparate technology tools used by various partner organisations into unified platforms.

Correspondingly, the organisation's internal requirements of skills, capacities and capabilities were very different now as compared to its old "avatar." For long, Arghyam's predominant requirement from its talent was to have project and programme management expertise. Individuals would personally manage grants for specific projects with specific partners, deep diving into water-related programmatic areas such as groundwater management, springshed management and water quality initiatives.

But Arghyam's new, digital-led strategy required them to identify and bring on board the right partner organisations with backgrounds in digital technology. This required equipping its internal talent with the much-needed technical know-how. The team needed to also be able to communicate these appropriately to a varied set of internal and external stakeholders (partner organisations, government agencies, other funders, regulators, communities and technical agencies).

Building these internal "muscles" started with Arghyam itself needing to be able to speak the language of digital technology. According to Jayamala:

> Technology cannot lead us, we have to lead technology, right? So, how does that work? If we have to have a seat at the table with technology people, we have to speak enough for us to get a seat at that table. So, all of us had to get primers on

> technology. I come from a completely non-technology world and had to understand, "*Yeh kya hai*? (what is this?) API[4]s *kya hai* ? (what are APIs)? What does it mean? What is Open Data[5]? What is Open Public Digital Good[6]? What is GitHub[7]?" All that we had to learn. We all had to learn.

While Arghyam's capabilities expanded, its perspective on what it meant to responsibly use resources remained unchanged: it continued keeping the organisation itself as lean as possible, and directing as much of its available funding to aid the development of its partner organisations as possible. Jayamala says:

> I don't think we want to grow to be too large an organisation. We want to keep our nucleus very small. We don't take money from anybody, right, we are a funding organisation. So, if you want to scale, you should have the ability to absorb other people's money also. And so therefore, we feel like we should not grow inside our game. We should rather let our partners grow, so that we can mission-align them, and other people can fund them. That's the way we are looking at it. Our own mission is to help the ecosystem actors grow, so that they can go and help people. So, we don't want to grow too much. But what we feel is, if we look at ourselves as the conductor of the orchestra, or whatever the right word is, that's what we need—we need an appreciation of all the instruments; we need an appreciation of players who play those instruments; but we shouldn't be getting into playing those. That's how we are looking at it. It's very difficult to really call it out.

This seeming contradiction, an expansive vision operating within this innate (fiscal) conservatism, meant that much weight would fall on the shoulders of each member of its small team. Clearly, this had a bearing on how individuals themselves were selected and not surprisingly, there was an exhaustive recruitment process, to search for individuals who possessed a certain outlook.

Composing the talent

To be able to nurture and retain people with such outlooks and competencies, Arghyam has designed an elaborate recruitment process. The recruitment stage marks the start of a deep integration between a new employee and the organisation's vision, mandate and people. The process creates enough opportunity for Arghyam and the candidate to get to know each other. Jayamala notes that it is not uncommon for the same person at Arghyam to interview a single candidate three times, and for it to take up to six months for a candidate to go through all the stages of the recruitment process. However, given that its total number of recruitments is very small, the organisation can afford to pay a great deal of attention to each hire.

Although working within the niche of water, Arghyam does not prioritise domain expertise in water during recruitment. A technical background is considered beneficial, but a candidate's perseverance,

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[4] Application Programming Interface (API): A software intermediary that allows multiple applications to communicate with each other. It enables programmers to use functionality from multiple applications without having to understand the detailed workings of each one.

[5] Open Data: a philosophy that believes that certain data should be freely available for all to use without intellectual property restrictions

[6] Open Public Digital Goods: public goods in the form of open-source software, open databases, models of artificial intelligence etc. Unlike a physical public good, digital public goods can be infinitely replicated and stored. They are considered an important means for nations to achieve their Sustainable Development Goals

[7] Github: A hosting platform that allows multiple software developers to contribute to and make changes to source code during the development of applications. It is commonly used to host open-source projects.

motivation and stamina to last at least three years in the organisation, working in a context where "success" is difficult to show within this timeline is prioritised much higher than a background in water. The aim is to nurture a pool of talent that is able to blend a highly cross-functional, collaborative and non-hierarchical mode of working within with strong individual leadership externally, to guide partners through a new and highly complex approach.

At a Crossroads of Success

Arghyam 4.0 is a crucible into which Arghyam is pushing itself and others to find the right blend of bringing scale to the revival of a small water groundwater civilisation: its organisational "North Star." Moving away from programmes to a mission-mode has meant that the success of the future will likely not resemble the past.

In the past, programmes demanded contact with the field and success was continuous and tangible. The success stories regularly supplied the requisite motivational dose to stay the course. Small victories added up to show an ecosystem at work. But the intent to scale the idea of a hyperlocal common-pool resource through collective participation, using a larger pool of public resources, both governmental and informational, seems powerful yet abstract, necessary but distant. For Arghyam, the challenge will remain to make it real, immediate and relatable to its own people, continuously replenishing its mission-drive.

Its mission-mode, as Arghyam is implicitly aware, also operates under greater weight of public obligation. As perhaps the only philanthropic institution of heft in water, the close support of public eminence in the personality of Rohini Nilekani has over the years provided opportunities to Arghyam that may not so easily be available to others; be it in fostering a dialogue within the ecosystem or influencing a national water agenda or to even dare dream of dissipating the inertia embedded in the water sector. However, discharge of this public duty is also confronting a different public expectation. Jayamala, speaking in 2021, reflects on this:

> The narrative has not changed one bit, in terms of the supply side. The demand side has changed very, very, drastically—people's expectations are very different today. I went to Jharkhand and a person asked me:
>
> "Do you have a tap in your house?"
> And I'm saying, "Yes."
> That person is like, "Do you get water?"
> "Yes."
> "Then why do you think I should not have that?"
>
> This is a tribal person in Jharkhand asking, and very rightly so. They are saying, "Why should I wait? Why should I do this groundwater [management], all this business you're telling me to do? It'll take three years to do. After that I'll get water; not get it to my home, I'll still have to walk 500 metres. Why?"
>
> I don't know the answer to that, but I agree with them—why?
>
> See, people are also changing. And you can't keep saying I'll do my old model, which will take three years to deliver something. So, even our partners have to learn and calibrate…the way we looked at it when we formulated the problem was, "Everybody's building cars, but who's building the road?" I think that same problem is everywhere. Nobody is investing in infrastructure in this sector. And I don't mean

> physical roads, I mean in software, in knowledge, in expertise, in sharing. That's not happening at all… We are today punching way below the problem.

Rohini, looking to the future, strikes a positive note on Arghyam's chosen direction, saying:

> It is scary, it is risky, it is outside our comfort zone as an organisation, but it fulfils the true role of philanthropic capital—which is to underwrite risk and innovation. So even if we fail, it is still the right thing to have tried.

After 20 years with Arghyam, on 30th of September, 2021, Rohini Nilekani stepped down from her role as Chairperson of the Board. Sunita Nadhamuni, Arghyam's founding CEO, took over the role from October 1st (TNN, 2021). On the decision, Rohini said:

> I have been planning retirement for a while because 20 years is really a good time to move on from an institution. I firmly believe all institutions need fresh thinking and a new leadership every once in a while…I have no regrets even though this is my personal foundation which has been exclusively funded by me. After all, once the money goes into a trust, it is money meant for public good, right? The team under the new chair, Sunita Nadhamuni, will take Arghyam to new heights of impact, I have no doubt about that. I will miss working with my colleagues, but this is the right decision, I am sure of that. After 20 years and hopefully having made some positive contribution to the water sector, it is only now, with this transition, that I can actually complete my "Arghyam."

An accidental philanthropist for sure, but she did ensure that Arghyam was not an accident: it was an act of as much intentionality as they come. It served to provide exhilaration and exhaustion in equal measure. Today, while the crisis silently brews beneath the ground, Arghyam is striving hard to bring together the forces above. It has—in its own, small way—shown the way to a small water praxis. Rohini, as she stepped out, would surely hope—Arghyam or no Arghyam—that more would continue to join the effort, and embed the common-pool paradigm deeper into the heart of the polity.

Exhibits

Given that the subject of water is complex and has elements which are simultaneously social and yet scientific and technical, the exhibits here are intended to provide readers with a detailed context. The reader may use these to supplement the reading of the main case. The sequence of exhibits broadly matches the flow of the case study. Exhibit 7: which discusses various aspects of groundwater security in the specific context of the city of Bengaluru, is also useful to bring together many of the ideas discussed in the main text of the case in a real-world setting.

Exhibit 1: India's water resources

The vast and intricate network of rivers across India have always fascinated the public imagination. They provide a useful starting point to unpack water in India. In 1988, the Central Water Commission (today, in 2022, a department under the Ministry of Jal Shakti which was itself formed in 2019 by merging the erstwhile Ministry of Water Resources, River Development and Ganga Rejuvenation and Ministry of Drinking Water and Sanitation) standardised India's river basins as 12 major river basins, and 8 composite basins (refer to Exhibit 3). These basins are recharged through annual precipitation (rainfall and snow). Annually, this precipitation stands at 3,880 billion cubic metres (bcm) (Central Ground Water Board, 2020). Much of this drains away almost immediately back into the oceans, and some evaporates away. Around 1,999.2 bcm of the 3,880 bcm which arrives as annual precipitation, is the total natural runoff that remains (and is the total amount that flows annually through the river basins of India). However, topographic and geological variations of the land itself means that not all of this runoff is accessible—or "utilisable"—for human use. All put together, of the 3,880 bcm received, only 1,126 bcm (less than a third) is "utilisable" (PIB Delhi, 2022).

Of the amount available for utilisation, around 436 bcm gets absorbed into the soil where it replenishes underground aquifers. This is the total replenishable groundwater India receives in a year. The remainder—690 bcm—is the total available surface water (PIB, 2022) (consisting of the four main sources: rivers, lakes, ponds, and man-made tanks/reservoirs).

Exhibit 2: Water availability in India

An important indicator of the status of water as it relates to the needs of human society is the per capita water availability (also known as water scarcity), which is determined by total population. While the available fresh water has stayed relatively constant over the years, the population has been increasing. One of the most widely used indicators of water availability for human use is the Falkenmark Water Stress Indicator, which sets a value of 1,700 cubic metres per person as the threshold for a "water-stressed" state. A per capita availability less than this in a particular region indicates water stress, whereas an availability less than 1,000 cubic metres indicates "chronic water scarcity." In 2021, India had an estimated per capita water availability of 1,486 cubic metres. Table 1 shows the variation of this indicator, as well as predicted estimates, between 1951 and 2061 (Central Water Commission, 2019).

Table 1: Per capita water availability in India

Year	Population (Million)	Per capita water availability (m^3/year)	Remarks
1951	361	5178	
1955	395	4732	
1991	846	2210	
2001	1027	1820	
2011	1211	1651	water stressed#
2015	1326*	1508[$]	water stressed#
2021	1345[a]	1486[$]	water stressed#
2031	1463[a]	1367[$]	water stressed#
2041	1560[a]	1282[$]	water stressed#
2051	1628[a]	1228[$]	water stressed#

Source: Central Water Commission, 2019

Exhibit 3: Major River basins of India

Table 2: Water resource availability and average rainfall received by major river basins of India

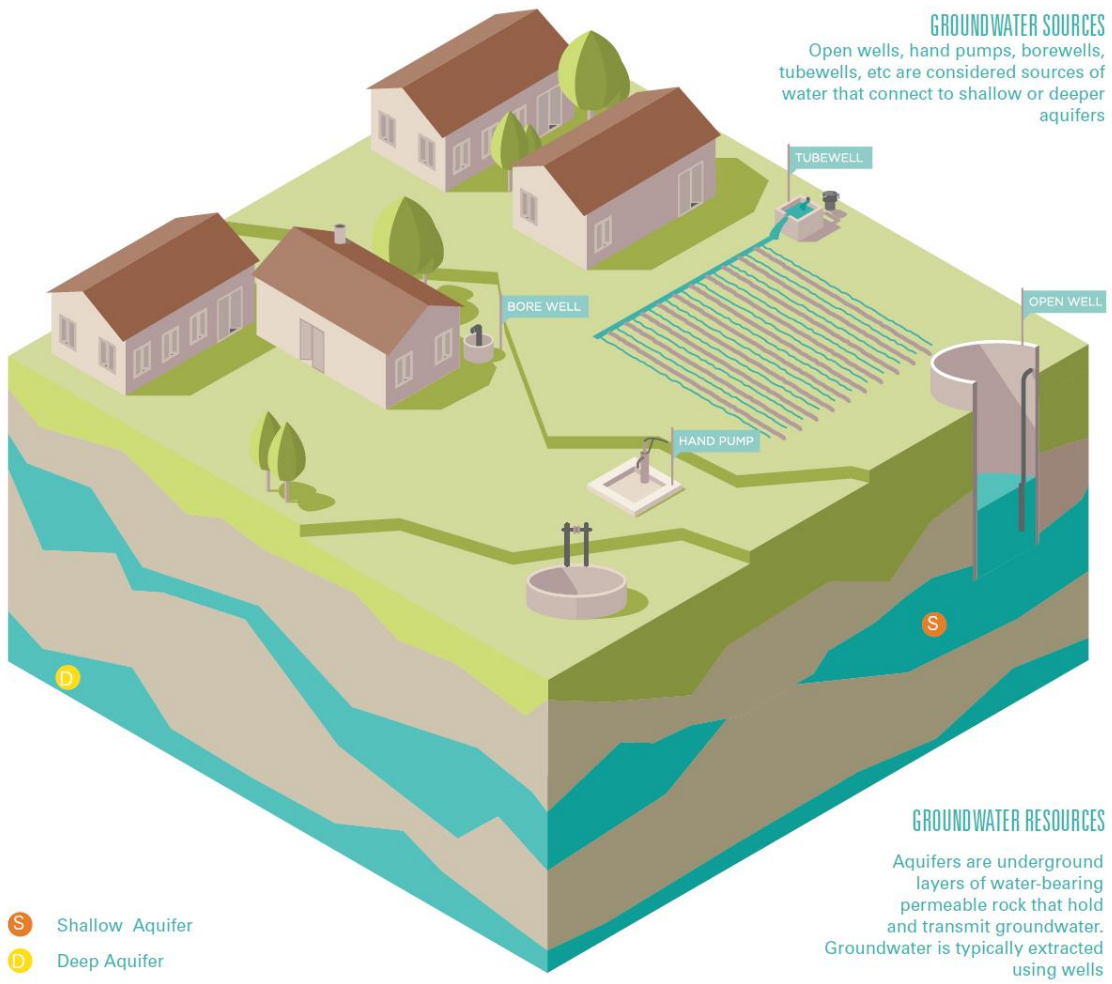
	River Basin	Average rainfall in water year (1985-2015) (bcm)	Average Water Resource Availability (bcm)
1	Indus (within India)	330	45.53
2	Ganga - Brahmaputra-Meghna		
2a	Ganga	914	509.52
2b	Brahmaputra	495	527.28
2c	Barak and others	134	86.67
3	Godavari	365	117.74
4	Krishna	226	89.04
5	Cauvery	81	27.67
6	Subarnarekha	40	15.05
7	Brahmani - Baitarani	83	35.65
8	Mahanadi	200	73
9	Pennar	40	11.02
10	Mahi	35	14.96
11	Sabarmati	25	12.96
12	Narmada	108	58.21
13	Tapi	59	26.24
14	West Flowing Rivers from Tapi to Tadri	161	118.35
15	West Flowing Rivers from Tadri to Kanyakumari	151	119.06
16	East Flowing Rivers between Mahanadi and Pennar	97	26.41
17	East Flowing Rivers between Pennar and Kanyakumari	98	26.74
18	West Flowing Rivers of Kutch and Saurashtra including Luni	100	26.93
19	Area of Inland Drainage in Rajasthan Desert	49	Negligible
20	Minor Rivers Draining into Myanmar (Burma) and Bangladesh	61	31.17
	Total	**3880***	**1999.2**

*Including 27 bcm from Ladakh

Source: Central Water Commission, 2019. Note: bcm stands for billion cubic metres.

Exhibit 4: Aquifers and groundwater sources

Fig. 1: Visualisation of shallow and deep aquifers and surface sources of groundwater



Source: Arghyam, 2015

Underground geological variations in India affect the distribution of groundwater, in similar ways to which land and climate characteristics affect the distribution of surface water. Water can only be absorbed and stored by certain types of soil. Hard rock areas are not permeable to rainwater, and this in turn affects the recharge rate of groundwater in the region. Thus, despite receiving adequate rainfall, a particular region may not be able to replenish its groundwater levels due to the nature of soil and rock formations underground.

Around 65% of India's total aquifer area comprises hard rock regions (mainly found in peninsular India) where groundwater recharge is only around 10% of the rainfall being received by the region. Such regions can therefore be in a critical state with regards to groundwater availability, despite receiving above-average precipitation (Chandrakanth, 2021). Refer to Exhibit 13 for a detailed overview of the types of aquifers and their relationship to groundwater recharge and availability.

Studies conducted using the data from NASA's GRACE (Gravity Recovery and Climate Experiment) satellites have shown that the Indus basin, covering the states of Punjab and Haryana, major food-producing regions of India, is the second most-stressed aquifer in the world. It is second only to the Arabian aquifer, which largely covers the desert regions of the Middle East (Mukunth, 2015).

In Bengaluru, Ahmedabad and Delhi, the depth-to-groundwater (a measure of the ease of reaching groundwater from the surface), has nearly doubled between 1998 and 2018 (Padmanabhan et al, 2019).

Adding to the story of Pulammadi village mentioned in the main text of the case (in section "Making an invisible problem visible" is the real experience of one of the villages residents—Bhujanga Reddy—a farmer who dug his first borewell in 1996, and relied on the water supplied by this single well to irrigate 10 acres of land for 20 years until 2016, when the well dried up. Since then, he has dug four consecutive borewells, all of which have failed. "I spent four lakh rupees. Now what do I do? I am sitting quiet and idle like everyone in our village. How do I repay the debt and move on?" he asks (Sudhir, 2016).

Fig. 2: Visualisation of regional and local aquifers

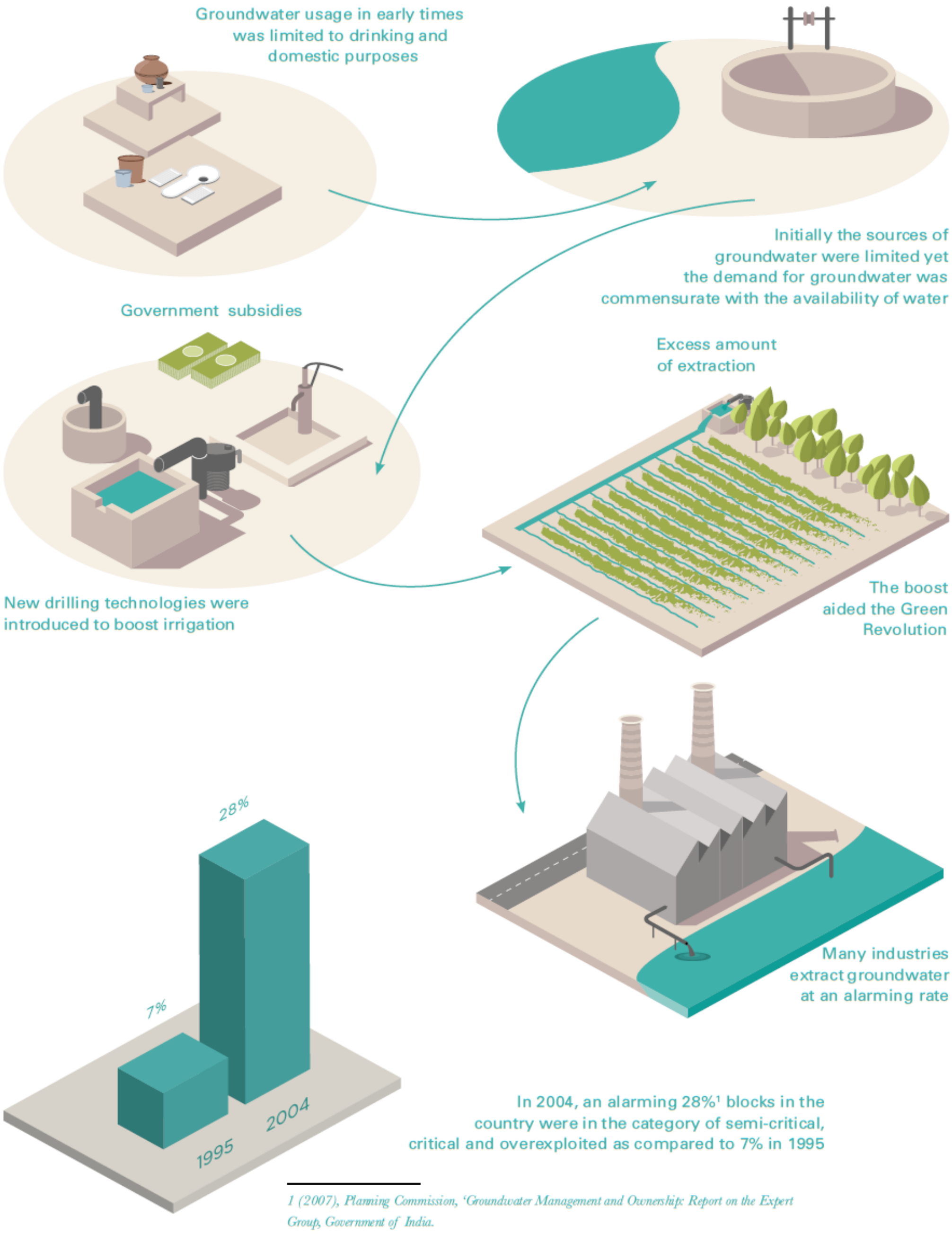
Source: Arghyam, 2015

Fig. 2 shows the examples of a particular region that encompasses two villages: Village A and Village B. It can be seen that the region contains two types of aquifers. The first, relatively shallow aquifer, is highly localised to Village A, in terms of its spatial extent. The second, deeper aquifer, can be seen to extend beneath both Village A and Village B.

This diagram highlights a key aspect of the nature of aquifers. They are able to traverse administrative, political and social boundaries. Correspondingly, their governance and management is deeply entwined with the nature of existing administrative, political and social structures and dynamics in a particular region. This is one element of the “hyperlocality” of groundwater as it relates to human society. The term hyperlocal relates to matters concerning a small community or geographical area.

Note: One implication of the Easement Act, 1882, discussed in the main text of the case study in section: “The legal conundrum,” can also be clearly seen in Fig. 2. The Act gives landowners free and unrestricted access to any water found beneath their land. Thus, suppose the well shown on the far left-hand side of Fig. 2—situated in Village B—was part of a privately-owned tract of land. The owner of this well would be within their rights to tap into the regional aquifer (covering both Village A and B), and extract its entire contents for private use, to the detriment of the entire populations of Villages A and B. The other residents (including the owner of the well), may not even be aware that they have equal claim to the aquifer or that the aquifer runs below their lands as well, due to its underground, invisible nature.

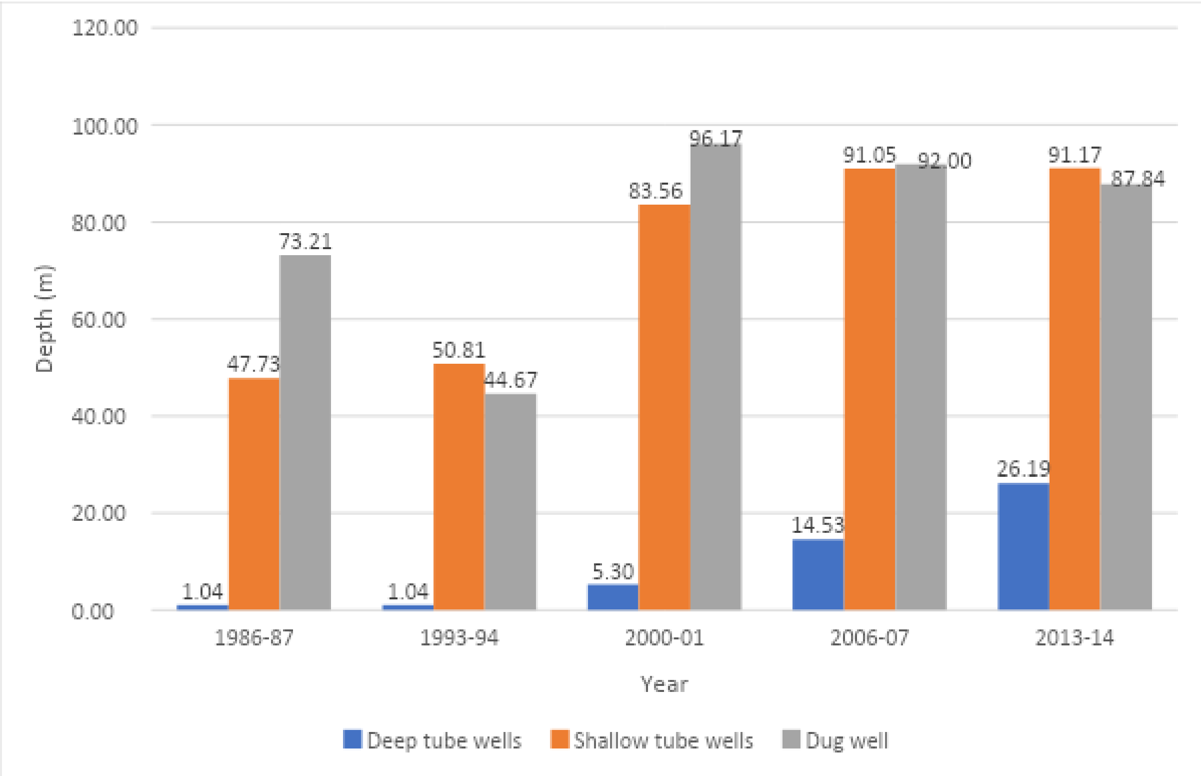
Fig. 3: Evolution of groundwater use in India



Source: Arghyam, 2015

Exhibit 5: Wells in India

Fig. 4: Time series of number and types of wells in India



Source : Rajan et. al, 2017

Note: The definitions of the well categories from the Minor Irrigation (MI) Census are as follows:

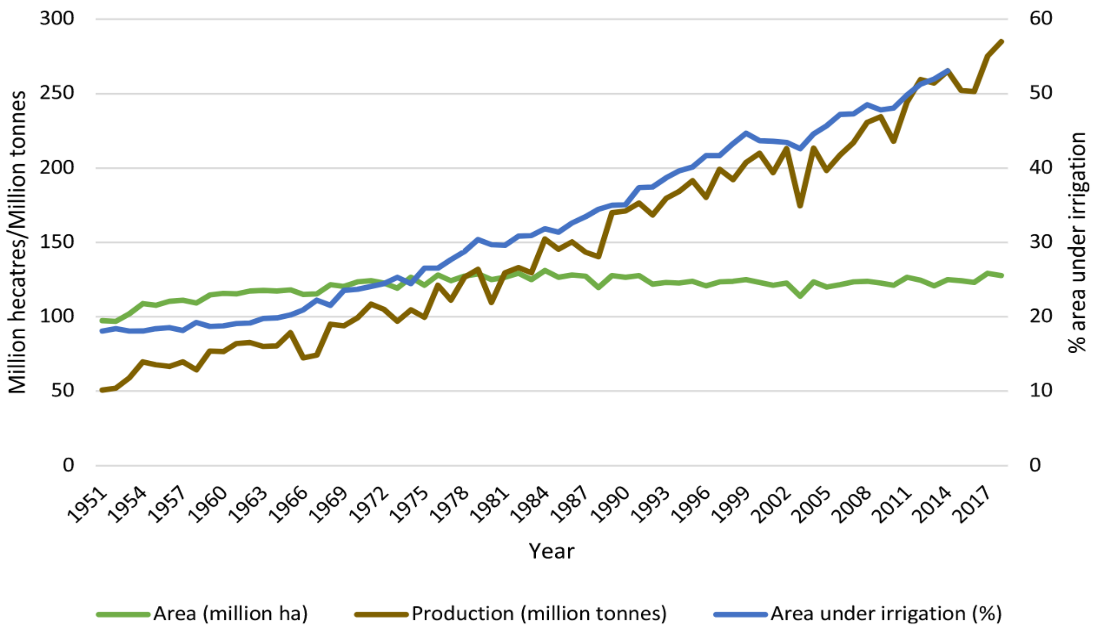
Dug well: Open well dug into the ground; can be of any depth, although 78% are less than 20 metres in depth.

Shallow tube well: Up to 70 metres depth

Deep tube wells: More than 70 metres depth

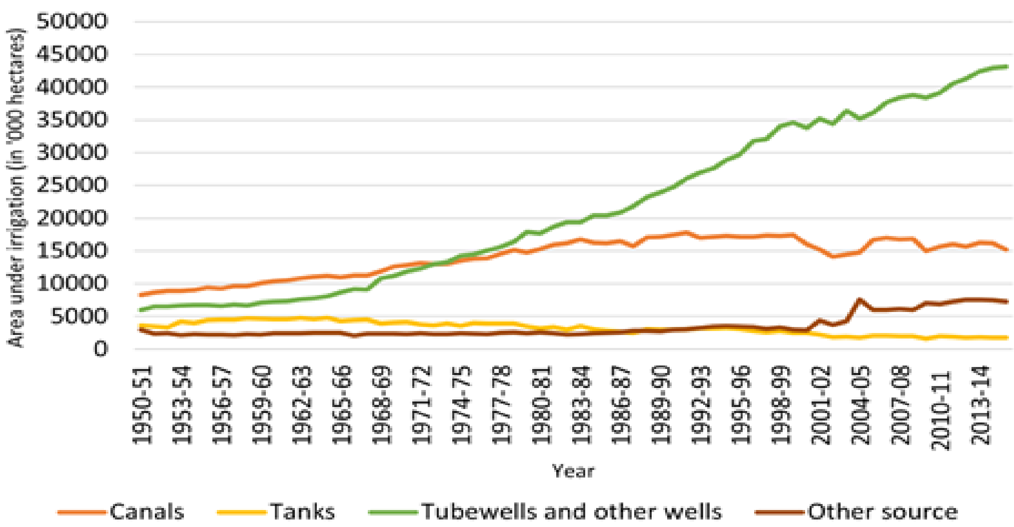
Exhibit 6: The Green Revolution

Fig. 5a: Area (million hectares) and production of food grains (million metric tons) and % area under irrigated for cereals 1950-51 to 2014-15.



Source: Mukherji, 2020

Fig. 5b: Area under different sources of irrigation 1950-51 to 2014-15 (thousand hectares)



Source: Mukherji, 2020

Prior to the Green Revolution, India had an overall food grain deficit. To give some measure of the expansion since the revolution: total food grain production in 2018 was more than triple that in 1960 (Mukherji, 2020).

Exhibit 7: Bengaluru: troubled waters

This exhibit uses the example of the city of Bengaluru to bring together many of the ideas discussed in the case into a real-world setting: to highlight the challenges of nurturing groundwater security in the context of a rapidly growing city.

In the space of a few decades, Bengaluru, Karnataka has transformed from a small city surrounded by farmlands, to one of the fastest growing cities in the world. It is today (2022) the bustling epicentre of India's IT sector, contributing 40% to the nation's total IT exports. Post-90s liberalisation of the Indian economy and large-scale private sector investments that followed, led to Bengaluru seeing an average annual GDP growth of 20.76% between 1993 and 2004 (relative to 7.93% for India over the same period)(Hussain, 2019).

The Bangalore Development Authority's most recent projections estimate that by 2031, the city's population will have more than doubled from its 2011 census levels: from 90.4 lakhs to 2.03 crores. This would place it above the current population of Delhi and Mumbai, the biggest urban centres of India. (Bharadwaj, 2017).

For the administration in charge of managing the city's needs, growth of this nature has resulted in huge challenges of urban planning. The city's geographical limits have tripled in the past decade, to include numerous peripheral villages (Yamini, 2022). Agricultural area has also increased around the city to feed its growing population. All of these facets of growth, in one way or another, converged on an unprecedented demand for water.

The closest major river to Bengaluru is the Cauvery river, one of the major rivers of India. The city however, is 100 km away and over 500 m above the elevation level of the Cauvery basin. Bengaluru Water Supply and Sewerage Board (BWSSB) spends over 60% of its budget pumping Cauvery water over this distance and elevation to meet the city's demands: paying an electricity bill of around Rs. 47 crores per month in 2022 (Yamini, 2022).

Of the total Cauvery water allotted for domestic use by the state of Karnataka, around 50% is used by Bengaluru alone. During the pumping and distribution process, around 49% of this total incoming water supply is wasted in the form of leakages and spillovers—the highest level of water wastage by any city apart from Kolkata (50% wastage).

In 2021, the total daily shortfall between the city's water demand and available supply was 650 million litres per day, projected to increase to 1,450 million litres per day by 2031 (Yamini, 2022).

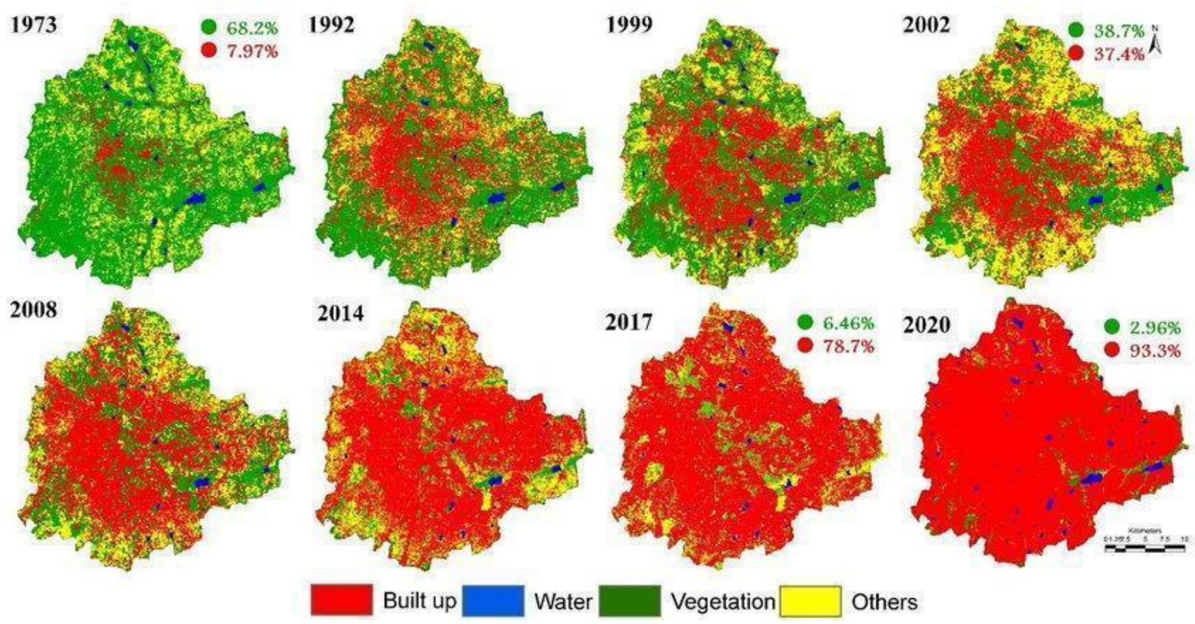
Further, Cauvery water is inequitably distributed around the city, with many regions not yet having a connection to supply from the river. Of 110 villages added to the municipal limits of Bengaluru in 2008, only around 41 had been connected to Cauvery supply by 2019 (Akshatha, 2019).

For a city of such a size without a steady, reliable surface water supply, what this has meant is rampant digging of borewells to access groundwater, something municipal authorities, on humanitarian grounds, can do nothing about. According to an official from the BWSSB: "We have banned digging borewells in the core area of the city, but we cannot impose such restrictions in outer areas that lack steady water supply." (Akshatha, 2019).

Thus, the municipal authorities are lenient with applications for new borewells, especially those coming from peripheral or newly-added areas that have been promised steady water supply by multiple governments, but are still waiting for the promise to materialise. Of the 250 applications for borewell drilling received each month by the BWSSB, around 90% are approved. Estimates place the number of legal borewells in Bengaluru at around 3.65 lakh (Akshatha, 2019), with the total number likely far greater including the illegal borewells that are a long-running issue in the city.

Around 80% of Bengaluru's landscape has some form of concretisation (compared to 4% in 1973) (Prasher, 2022), which impedes the recharge of groundwater supplies through rains; the presence of tree cover allows water to percolate into soil and recharge groundwater. Another factor affecting recharge of groundwaters is the slow disappearance of surface lakes from the city's landscape over the years, reducing the amount of water naturally seeping into the ground. Over the past four decades, one estimate puts the loss of water bodies and green cover in the city at 79% and 89% respectively (Hussain, 2019) With over 45% of the city depending on groundwater, the outcome has been ever-increasing depths of borewell drilling to find aquifers that still bear water (Thakur, 2020).

Fig. 6: Land use changes in Bengaluru 1973-2020

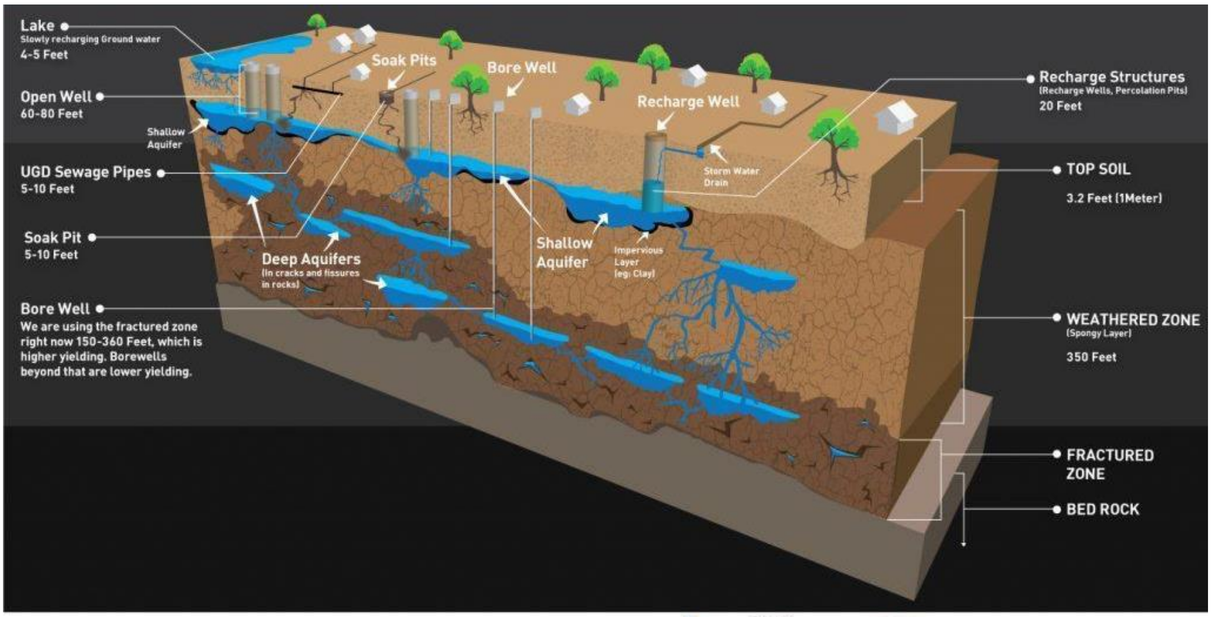


Source: Ramachandra et al. (2017)

Fig. 7 shows a visualisation of Bengaluru's geology and groundwater resources, along with the relative depths of various features. The diagram indicates the presence of shallow and deep aquifers, as well as an indication of the soil and rock structures below ground in the city. It is possible to see the extraction structures (open wells, bore wells, and soak pits), as well as recharge structures attempting to recharge groundwater levels (recharge wells and percolation pits). Urban infrastructure in the form of storm water drains and sewage pipes also form a piece of the subterranean puzzle.

The underlying geology of Bengaluru consists of fractured granite structures ("fractured zone"). It is into this layer that, as of 2020, borewells up to depths of 1,900 ft were being drilled, to tap deep aquifers (Thakur, 2020). The layout of these underground fractures is particularly important with regards to drilling borewells. Once drilled, water accumulates in a bore well at a level that is entirely determined by the rock fractures in the walls of the well. Fractures can be "dry," or themselves bear water. These water-bearing fractures are called "yielding fractures." Thus, the water in a single borewell can come from the aquifer it taps into, as well as from various "yielding fractures" present along the walls of the borehole.

Fig. 7: Visualisation of Bengaluru groundwater-related surface structures and subterranean geology



Source: Aquifers (2018)

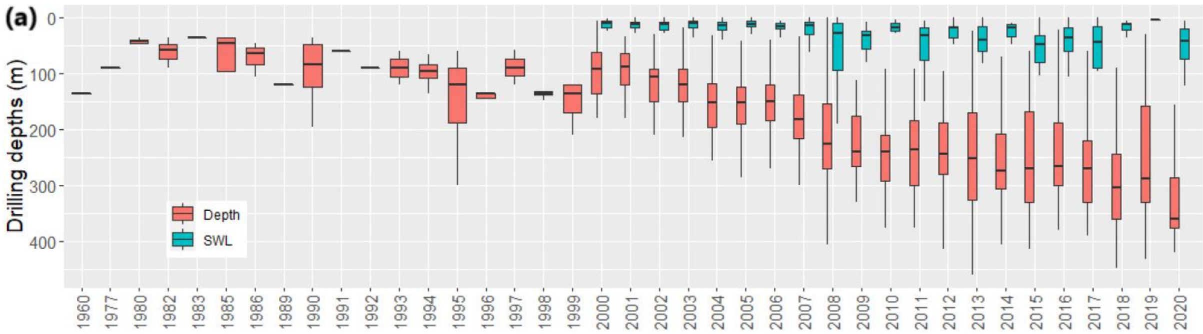
Kulkarni et al (2021) found, in their study of borewell data from Bengaluru from the 1960s (compiled from logs kept by local hydrogeologists, borewell drilling companies, and farmers) that average borewell depths had steadily increased in Bengaluru over 50 years between 1960 and 2020. Table 3 shows summary data of drilling depths in the city, while Figure 8 shows a detailed distribution of the drilling depths over the same period, including the maximum depths recorded in each year. Of the studied wells the study found a maximum drilling depth of 430 m (1411 ft) in 2020. Other sources indicated the presence of borewells at depths of 1900 ft (579 m) in Bengaluru in 2020.

Table 3: Borewell drilling depths over time in Bengaluru: urban, peri-urban and rural areas

Parameter	Time period	Location category		
		Urban	Peri-urban	Rural
Drilling depths of borewells (m)	Pre-2000	N/A	120.1	105.1
	2000-2010	125	152.2	180.2
	2011-2020	211	264.6	301.8

Source: Kulkarni et al, 2021

Fig. 8: Distribution of borewell depths and static water level (SWL) in Bengaluru 1960-2020



Source: Kulkarni et al, 2021

Drilling this deep also has implications for the quality of water found. The Central Ground Water Board reports that groundwater samples from Bengaluru had chemical constituents in the water (fluoride, nitrates, arsenic, irons and heavy metals such as lead, cadmium and chromium) that were higher than permissible limits. Dr Ramachandra of the Centre for Ecological Sciences at the Indian Institute of Science in Bengaluru says:

> This happens when you go deeper into the water table and touch the geological strata that have trace elements. Water quality starts degrading. The only way to improve groundwater quality is by improving land cover and land use, augmenting recharge capacity…Our study has shown when the catchment has native species of vegetation, water is available throughout the year. We have 193 lakes in the city. If we desilt these and manage the catchment areas, groundwater levels will increase. Sarakki lake in South Bengaluru is a case in point. The lake was restored two years ago; residents will testify that groundwater levels shot up by 150 feet within a year. (Prasher, 2022).

Exhibit 8: Measuring the status of groundwater

The Central Ground Water Board (CGWB) is an office of the Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti.

To help states and local government institutions develop regional policies for groundwater management, CGWBs groundwater assessment methodology divides the country into a total of 6,965 assessment units across the districts, blocks, *mandals*, *talukas* and *firkas* of India. Each assessment unit is assessed for its "stage of groundwater extraction": the percentage utilisation of groundwater with respect to the total annual extractable groundwater resources available in that unit. The resulting figure is validated against long-term water level trends in the region, and used to categorise an assessment unit's groundwater status as: "Safe," "Semi-critical," "Critical," "Over-exploited," or "Saline" (Central Ground Water Board, 2020).

Pumping groundwater from aquifers faster than they can be recharged (which in India, happens almost entirely through monsoon rains) results in increasing concentration of salts, heavy metals and ions (such as fluorides, nitrates and arsenic) in the water. Over time, the water can become permanently unfit for use. This is what the category "Saline" means in the context of groundwater assessment.

There is a similar interaction between groundwater aquifers and open defecation in rural India. Where waste streams are not kept separate from water streams, contamination quickly enters the groundwater, which then gets pulled up for domestic use.

Table 4: Groundwater assessment unit categorisation, 2004-2020

Categorisation of Blocks/Madals/Talukas	2004	2009	2013	2017	2020
Total no. of Assessment Units	5723	5842	6584	6881	6965
Safe	71%	73%	69%	63%	64%
Semi-critical	10%	9%	10%	14%	15%
Critical	4%	3%	4%	5%	4%
Overexploited	15%	14%	16%	17%	16%
Saline	1%	1%	1%	1%	1%

Source: Central Ground Water Board, 2020

Exhibit 9: Water governance in India: a complex challenge

Mihir Shah, Indian economist, member of the former Planning Commission of India, and co-founder of Samaj Pragati Sahayog, an Indian grassroots initiative addressing water security, says:

> Ever since Independence, the governance of water has suffered from at least three kinds of “hydro-schizophrenia”: that between irrigation and drinking water, surface and groundwater, and also water and wastewater. Government departments at the Centre and states have generally dealt with just one side of these binaries, working in silos, without coordination with the other side. As a result, critical inter-connections in the water cycle have been ignored, seriously aggravating our water problems.
>
> For example, when we see so many peninsular rivers drying up, we do not connect it to over-extraction of groundwater, which reduces the base-flows critical for rivers to have water even after the monsoon rains are over. Similarly, dealing with drinking water and irrigation in silos has meant that aquifers providing assured sources of drinking water tend to get depleted and dry up over time, because the same aquifers are used for irrigation, which consumes much higher volumes of water. This has adversely impacted the availability of safe drinking water in many areas. And when water and wastewater are separated in planning, the result generally is a fall in water quality, as wastewater ends up polluting supplies of water. The fact that the responsibility to monitor and ensure water quality is also divided over a number of distinct and uncoordinated agencies again leads to an overall deterioration in water quality.
>
> Thus, when it comes to various aspects of fresh water: agencies in charge of drinking water may not know what is happening in irrigation. Groundwater agencies may not communicate with surface water. (Mukherji, 2021)

The draft of the National Water Framework bill, 2016, framed by the committee headed by Mihir Shah, also aimed to shift the language and thinking that has historically dominated groundwater governance—a largely instrumental lens devoid of the language of sustainability—by highlighting an important facet of water governance: its multi-dimensionality.

> Water is the common heritage of the people of India; is essential for the sustenance of life in all its forms; an integral part of the ecological system, sustaining and being sustained by it; a basic requirement for livelihoods; a cleaning agent; a necessary input for economic activity such as agriculture, industry, and commerce; a means of transportation; a means of recreation; an inseparable part of a people's landscape, society, history and culture; and in many cultures, a sacred substance, being venerated in some as a divinity. (Shah, 2018).

In 2015, to attempt a systemic shift in the way groundwater governance was approached in India, a seven-member committee chaired by Mihir Shah was invited by the then Ministry of Water Resources (now a department under Ministry of Jal Shakti formed in 2019) to restructure the two national apex bodies on water—the Central Water Commission (CWC) and the Central Ground Water Board (CGWB)—to optimise the development of water resources in the country. The key recommendation of the committee was the setting up of the National Water Commission, a single and integrated apex body dealing with India's water policy, data and governance, subsuming the CWC and the CGWB (Standing Committee on Water Resources, 2016).

The deeper contours of this key recommendation were based on several findings by the Mihir Shah committee. The CWC, formed in 1945, and the CGWB, formed in 1970, were highlighted as being highly bureaucratic structures, containing a "quagmire" of hundreds of different designations, which encouraged siloed viewing of responsibilities with little understanding of the systemic picture of the water space (the same pattern was also seen to apply to corresponding state-level water governance bodies).

Further, the mandate of these institutions had been laid out at a time when the predominant narrative for addressing water security in India was through the construction of large-scale dams, managed and governed through centralised bodies and processes. With this narrative having shifted significantly over the past 50 years due to, for instance: environmental sustainability concerns over large-scale damming, the rapidly increasing dependence on groundwater relative to surface water, and the emergence of decentralised participatory processes as a way to govern water resources, it was observed that the apex agencies had not undergone any reform to reflect the changing times (Mukherji, 2021).

Some of the key features of the proposed National Water Commission were: the inclusion of a multi-disciplinary leadership team, consisting not just of engineers and hydrogeologists, but also representation from sectors of river ecology, agronomy (crop production and soil management), social sciences and participatory natural resource planning and management; an extensive regional presence to take into account the multitude of local contexts and high spatial variations in water use and availability in India; demand-side management (rather than continuous augmentation of supplies), sustainability, and equity of access as critical areas of policy emphasis; and the creation of a transparent, user-friendly data management system of water information for citizens to be able to solve their own water problems (Shah, 2018).

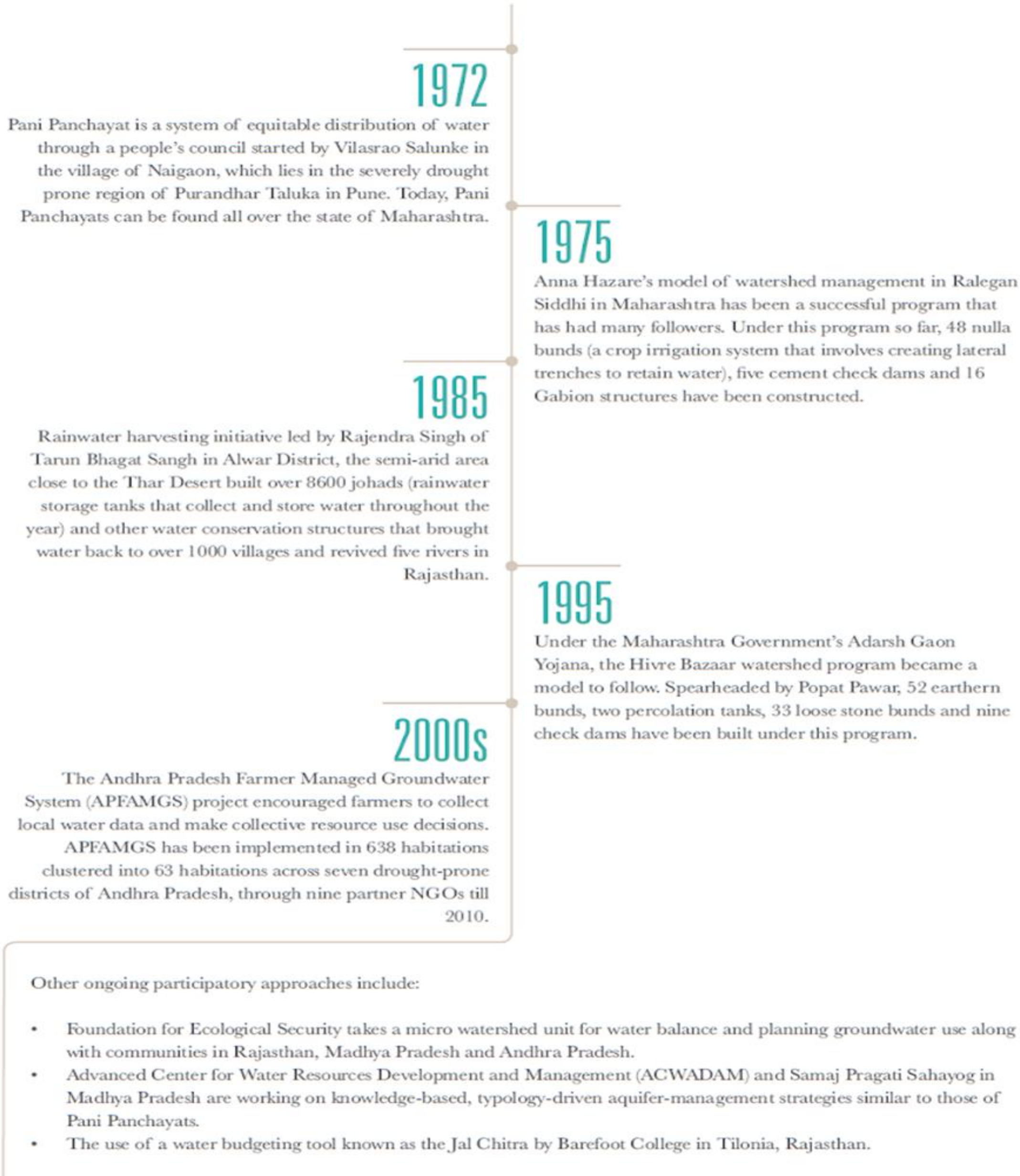
All put together, governance and management of water and groundwater is thus a highly complex problem that goes beyond most of the natural resource management challenges we face.

Exhibit 10: Beyond State: civil society and water

MYRADA, founded in 1968 and working in drought-prone areas in Karnataka to help communities with water conservation methods, is an early example of the involvement of a NGO in the water space (MYRADA, 2022). The N M Sadguru Water and Development foundation, established in 1974, was another one of the earliest NGOs to receive formal recognition and funding from central and multiple state governments (Ministry of Rural Development of Gujarat, Rajasthan and Madhya Pradesh) and international development agencies to design and deliver programs centred around land and water resource management in rural and tribal areas (Organisational Profile, 2016).

Figure 9 gives a timeline of a sample of civil society-led participatory approaches in India for water resource management.

Fig. 9: Examples of participatory approaches in water resource management



Source: Arghyam, 2015

Exhibit 11: Managing common-pool resources

The following is an extract from an article which appeared on India Water Portal about the challenges of managing commons (common-pool resources) (Shah et. al, 2020).

Common-pool resources, popularly known as "commons," are those resources which are accessible to the whole community or village and to which no individual has exclusive ownership or property rights. Commons have two essential characteristics: non-excludability and high-subtractability. Non-excludability means that it is impossible or very costly to restrict a user from using the resource, and subtractability or "rivalness" means that use of the resource by one user will diminish benefits for other users. In the context of India, commons include community forests, common grazing grounds, tanks and tank beds, foreshores, threshing grounds, rivers and riverbeds, where well-defined property regime may not exist.

On December 25, 2019, Prime Minister Narendra Modi launched the long-awaited Atal Bhujal Yojana (ABhY, Atal Jal). The Panchayat-led programme's design incorporates principles of participatory groundwater management and behavioural change with primary focus on demand side management in seven states of India. Success of the program would depend largely on its ability to create mechanisms for managing groundwater as a common-pool resource.

Challenges in managing commons

As widely studied and acknowledged in the past, commons are facing overconsumption and under-investment leading to depletion. This often results from individuals trying to maximise their own gains rather than work towards collective outcomes, which is referred to as tragedy of commons. Forests are being wiped out for development of infrastructure and industries, catchments feeding into water bodies are degraded, tanks and riverbeds are encroached for agricultural and real-estate purposes, and groundwater overexploitation has resulted in loss of livelihoods and even life in some cases.

The main challenge with managing commons stems from the existence of multiple uses and users that compete for the resource. Because of shared rights of usage, unrestricted access and unregulated use, the accountability for maintaining commons is largely not established and users often resort to blame-game on the face of dwindling resources. A major hurdle in making commons management work sustainably is to shift from competition to cooperation, which is heavily dependent on existing social capital.

Management of any common-pool resource requires institutions formed by users and protectors of the resource. Institutional arrangements to manage these resources are, however, either non-existent or non-functional. These institutions must set rules and regulations, which take the shape of social protocols that establish mechanisms to penalise defection.

There are few instances of communities taking back their rights to manage their commons effectively. In the case of groundwater, for instance, several NGOs have been working with communities to establish models for participatory management. All these models, however, require extensive handholding of communities and long-term engagement by resource organisations—which are not possible at scale given the limited human resources available. To enable such a change at national scale, local communities need to be involved and self-governance institutions need to be promoted to sustainably manage and govern natural resources. Doing this requires community members to acquire necessary knowledge and skills to enhance their capacities.

Role of technology, knowledge, and capacity creation in management of commons

Collective action of local communities can help balance the use of commons for ecological well-being, social justice, and economic opportunities. This requires amalgamation of traditional knowledge with scientific understanding of resources. Communities already understand the former but need a nudge in the right direction to utilise them in action. Foundation for Ecological Security (FES), an NGO founded in 2001, has been engaging with communities to restore commons and has successfully intervened in over 10,000 villages, restoring more than 200,000 hectares of common lands and forests, apart from water resources in India.

Through their *Prakriti Karyashala* model, they have been strengthening community institutions, building capacities of local resource persons and panchayat functionaries to map, restore, and manage commons better by leveraging government funds under MGNREGA. This has helped in overcoming the gaps in programme implementation and building stewardship over the assets created.

FES has initiated the use of technology to democratise knowledge and assist in better decision making at the community level. The technology solutions support local communities and other stakeholders in harnessing the potential of data and information for informed conservation action at scale and evidence-based decision making. Using tools like Composite Land Assessment and Restoration Tool has helped in demarcation of common land to outline encroachments and understand potential for securing commons. FES has also promoted tools for performing Crop Water Budgeting exercises collectively in villages on a regular basis for efficient management of water resources. The whole process from identification of commons to securing and restoring them is done by empowering communities with knowledge, data, and tools.

The field trainers of FES who engage directly with communities are equipped with necessary tools to map commons, build and strengthen community institutions, mobilise resources, and support communities to sustainably manage the secured resources. But, given the depth of engagements, the trainers often find it difficult to reach out to communities in multiple villages allotted to them. Often, sensitive issues like clearing of encroachments require consultations with government authorities at higher administrative levels and entails collaborative efforts of multiple stakeholders.

The field trainers currently depend on ad-hoc communication mechanisms to reach out to concerned stakeholders leading to delays in decision making. Mechanisms to resolve some of these communication barriers could help these resource agencies scale up their work much faster and cater to more number of villages - which is the need of the hour given the scale of the problem around commons management.

Exhibit 12: PGWM execution partners of Arghyam

Table 5: PGWM Project Partners

PGWM Project Partner (Resource Centre)	Description
Advanced Centre for Water Resources Development and Management (ACWADAM)	ACWADAM is a not-for-profit organisation that aims to develop solutions to groundwater problems of today and tomorrow. It is a premier education and research institution and facilitates work on groundwater management through action research programmes and trainings
Arid Communities and Technologies (ACT)	ACT is a non-profit organisation working in the Kachchh region of Gujarat. It aims to

	strengthen the livelihoods of communities in arid and semi-arid regions by resolving ecological constraints through facilitation or by providing access to technologies and by engendering technological and institutional solutions.
People's Science Institute (PSI)	PSI is a non-profit organisation with a work focus in the Indian Himalayan region and the poverty-stricken Bundelkhand region. It aims to eradicate poverty through the empowerment of the poor and the productive, sustainable and equitable use of natural and human resources.
Watershed Support Services and Activities Network (WASSAN)	WASSAN is a network that works towards bringing about a qualitative change in the watershed-based development programmes in India. It aims at providing capacity building and support services for development initiatives in natural resources management with a focus on promoting livelihoods of poor, economic and gender-discriminated citizens.

Source: Rangan, 2016

Exhibit 13: PGWM and hydrogeological settings of India

Fig. 10: Hydrogeological settings of India and their characteristics

The different hydrogeological typologies in India

Mountain systems
Found mainly in the Himalayan region, mountain systems are local aquifers found over a large region that feeds springs and streams. They demonstrate higher dependency for drinking water on springs and spring-fed streams than on wells. Land-use change and climate are factors of immediate concern around this resource's sensitivity.

Alluvial (unconsolidated) systems
Alluvial systems are unconsolidated river and aeolian sediments that deposit in vast plains, largely within the Indus and Ganga river basins typified by multiple regional aquifer systems. Groundwater quality in these regions is a major concern.

Sedimentary (soft) systems
Sedimentary (soft) systems are regional aquifers found over smaller regions in Central Indian drylands. They have a strong coherence with forests, mining areas and tribal dominant regions - regions that have higher dependency on groundwater for domestic usage.

Sedimentary (hard) systems
Found mainly in Central Indian drylands, sedimentary (hard) systems are local aquifers spread over smaller regions, again demonstrating a strong coherence with forests, mining areas and tribal dominant regions. Most of these regions have high dependency on groundwater for domestic usage and agriculture. Some areas in these regions have witnessed significant extraction of groundwater.

Volcanic systems
Volcanic systems are found over large regions and are the most heterogeneous of all aquifer systems. With limited amounts of storage, these aquifers often lead to some degree of self-regulating storage. Long term declines of these systems lead to constrained agricultural growth. Relatively better water quality levels can be found here.

Crystalline (basalt) systems
Crystalline systems are local to sub-regional aquifers found over large regions. These regions have a high dependency on groundwater for drinking water and agriculture. Groundwater markets arise primarily around rural to urban groundwater transfers. Fluoride tends to be a major contaminant in these systems.

Source : (2015) Kulkarni et al, Shaping the contours of groundwater governance in India, Journal of Hydrology : Regional Studies

Source: Arghyam, 2015

Figure 10 highlights the diversity of hydrogeological settings in India, as well as summarises their key characteristics. These characteristics determine the processes by which groundwater moves through and accumulates in local aquifers in each of these settings. These processes are unique to each setting, and cannot be compared across settings. Thus, notions of groundwater development, the most suitable strategies for groundwater management, as well as the most suitable interventions to prevent overexploitation, will vary significantly across these settings. Thus, "hyperlocality" as it relates to groundwater, is not only a result of the different cultures and relationships of different communities with nature across India, but also non-human factors such as topography (presence of mountains, plains, valleys, rivers, lakes), presence of terrestrial ecosystems such as forests, and geology.

In the context of Arghyam's Participatory Groundwater Management Program (which now also forms a part of the Atal Bhujal Yojana: ref. Exhibit 14), a mountain setting would require a very different approach to a plains (alluvial) setting. Mihir Shah elaborates:

> Participatory Groundwater Management (PGWM), being pioneered through the Atal Bhujal Yojana, must form the backbone of groundwater programmes in both rural and urban areas. Information on aquifer boundaries, water storage capacity and flows in aquifers should be provided in an accessible, user-friendly manner to primary stakeholders, designated as the custodians of their own aquifers, to enable them to develop protocols for sustainable and equitable management of groundwater. PGWM must be implemented in a location-specific manner that takes into account the diversity of India's hydrogeological settings. The NWP also proposes that the National Aquifer Management Programme (NAQUIM) adopt a bottom-up approach and provide maps at a scale of 1:10,000. Only by going down to this scale will the information provided by NAQUIM be in a form that is usable for the main stakeholders engaged in aligning their cropping patterns to the availability of groundwater… (Shah, 2021)

Exhibit 14: *Atal Bhujal Yojana*

Atal Bhujal Yojana is a central government scheme, implemented by the Department of Water Resources, River Development and Ganga Rejuvenation (DoWR, RD&GR), Ministry of Jal Shakti. Its primary objective is "to improve the management of groundwater resources in the water stressed areas of the selected states." This will be achieved by implementing appropriate investments/management actions led by the community through convergence of various ongoing /new central and state schemes.

The scheme has a total outlay of Rs. 6,000 crore, with an equal contribution of Rs. 3,000 crore each from the Government of India and the World Bank. Table 6 below shows the participating states, local government breakdown, as well as tentative budget allocation to each state.

Between them, the participating states account for about 37% of the water-stressed blocks in India (where groundwater assessment has indicated an overexploited, critical or semi-critical state).

Table 6: *Atal Bhujal Yojana* participating states and budget allocations

S.No.	State	Districts	Blocks	*Gram Panchayats*	Budget allocation (INR crores)	
					Institutional Strengthening and Capacity Building component	Incentive component
1	NPMU				159.33	
2	Gujarat	6	24	1,816	217.65	539.11
3	Haryana	13	36	1,895	252.67	470.52
4	Karnataka	14	41	1,199	194.51	1007.01
5	Madhya Pradesh	5	9	678	103.62	210.92
6	Maharashtra	13	35	1,339	188.26	737.51
7	Rajasthan	17	22	876	164.68	1024.97
8	Uttar Pradesh	10	26	550	119.28	609.96
TOTAL		**78**	**193**	**8,353**	**1,400.00**	**4,600.00**

Source: *Atal Bhujal Yojana* Program Guidelines, 2020.

Note: NPMU is the National Program Management Unit – a central unit established within the Department of Water Resources, River Development and Ganga Rejuvenation (DoWR, RD&GR) mandated with the overall responsibility for implementing the Yojana.

The scheme has two primary components:

1. Institutional strengthening and capacity building component: aimed at strengthening the groundwater governance mechanism in the participating States
2. Incentive component: aimed at strengthening the groundwater governance mechanism in the participating States

Table 7 shows the budget allocation between the components of the scheme.

Table 7: Budget allocation between main components of *Atal Bhujal Yojana*

	Budget allocation (INR Crores)		
	Govt. of India	World Bank	Total
Institutional Strengthening and Capacity Building component	1400	-	1400
Incentive component	1600	3000	4600
	3000	3000	6000

Source: *Atal Bhujal Yojana* Program Guidelines, 2020.

The scheme has been designed as a pilot with the principal objective of strengthening the institutional framework for participatory groundwater management (PGWM). It also aims at bringing about behavioural change at the community level through awareness programs and capacity building for fostering sustainable groundwater management in the participating States.

In particular, the programme lays out a formal institutional framework connecting groundwater management activities, actors and agencies at Gram Panchayats, district, state and central government levels.

The scheme's budget model involves a component called "disbursement-linked indicators: (DLIs). These are specific indicators linked to the disbursement of World Bank funds. Funds will only be released subject to achievement of indicators by the implementing agencies of the project. One of the five DLIs of the project is linked directly to the roll-out of a standardised bottom-up participatory groundwater planning process in all participating states.

Further, the Incentive component of *Atal Bhujal Yojana* is based on the "Challenge Method"—where participating states are challenged to give their best in achieving results. The better the performance of states, the higher the incentive disbursement they are entitled to. One of the key areas where states will be challenged to perform is in "encouraging innovation and technology, through the use of remote sensing and GIS (Geographic Information Systems)."

This aspect of the *Yojana* has in turn shaped Arghyam's design and development of open source digital platforms for groundwater management (see section Arghyam 4.0 in the main case study) (Ministry of Jal Shakti, 2020).

Exhibit 15: Digital technology for scale in Arghyam 4.0

Arghyam's intent with the use of digital technology is to achieve scale by working towards a convergence of efforts in the water sector. The idea is for the design of the digital operating model to enable convergence between existing programmes and between work already done in past programmes to help communities solve water security issues at speed and at scale.

The approach relies on three major tools. The digital operating model brings these tools together on a single, open-source platform, made available for communities. The tools are:

Participatory Digital Attestation (PDA): This is a way to build a "digital footprint" for work done in the water sector. It allows detailed records to be kept of each interaction within a particular field programme, such as the participants, trainers, experts and any content created. This data and content can then be accessed by future programmes and reused for similar contexts, without having to start from scratch. The Participatory Digital Attestation platform is provided by Socion, a strategy advisor to social purpose organisations. It is built as a "single platform to build and nurture human capacity at scale," with a specific focus on empowering front-line workers with real-time data and content.

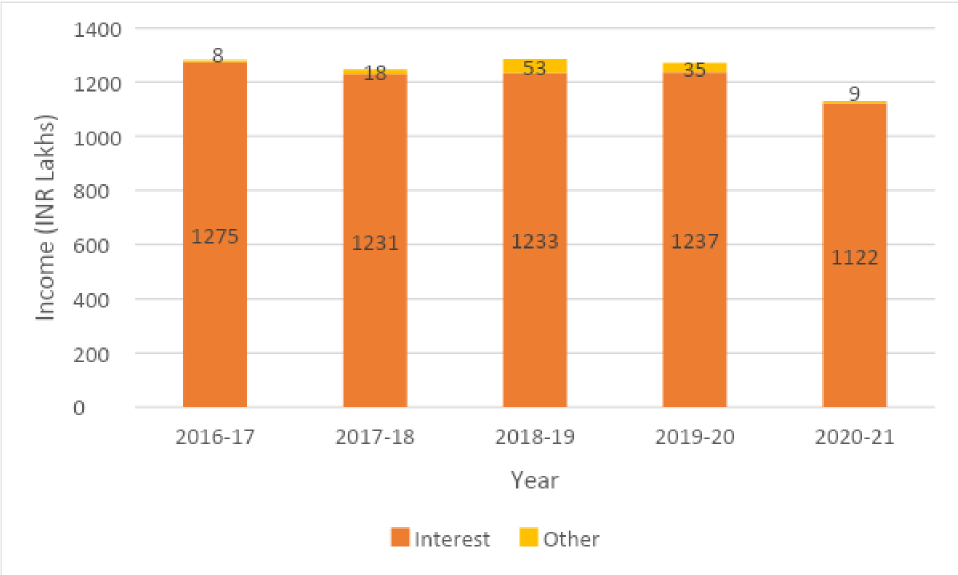
Composite Landscape and Restoration Tool (CLART): This is a Geographic Information System (GIS) tool available for the Android mobile platform. Its purpose is to enhance region-specific soil and water conservation measures. The platform is specifically designed to have offline functionality (in case of limited network access), and for a user-friendly interface for semi-literate rural communities. The platform helps rural communities design measures to aid in groundwater recharge, taking into account regional hydrogeological characteristics. The objective is for communities to be able to do a large part of the designing and planning of groundwater management themselves, without having to rely on experts or assistance from government officials.

India Water Portal: This resource, although launched in 2007, is being reimagined and updated for greater convergence with modern digital technologies, primarily smartphones. The latest version will provide more accessibility to audiences beyond the research community.

Over the first 18 months of Arghyam launching their digital commons platform (starting around midway through 2019), 2,500 pieces of learning content on various topics has been created and made available. Communities have between them generated 60,107 plans using CLART. 13,000 unique practitioners and experts have accessed the digital commons, and over 5,000 interactions recorded on PDA. (Arghyam, 2021).

Exhibit 16: Arghyam financial data

Fig. 11: Arghyam revenue trends 2017-2021



Source: Arghyam Annual Reports 2017-2021.

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