FUNDAMATICS

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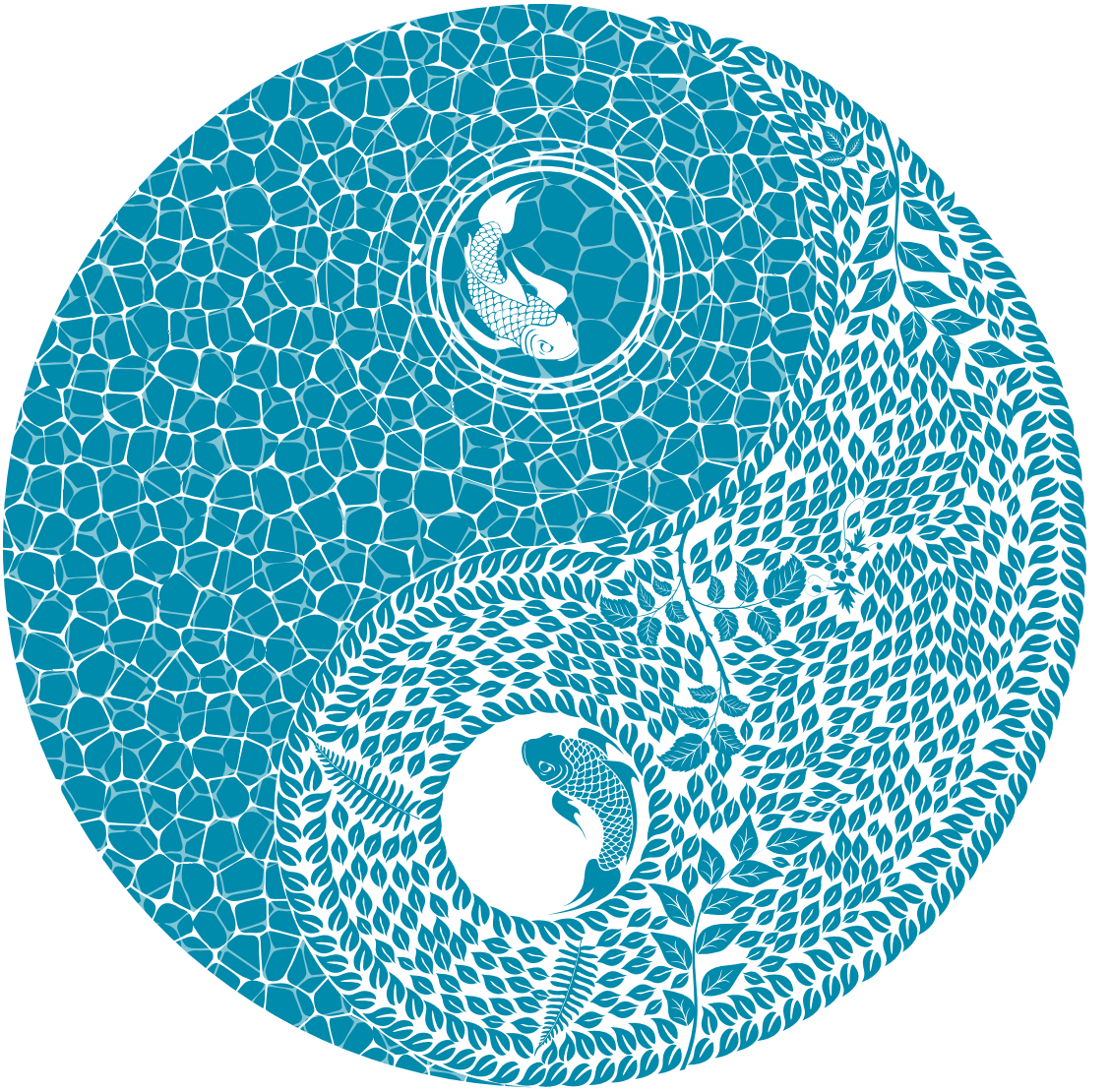

"Strong reasons make strong actions"

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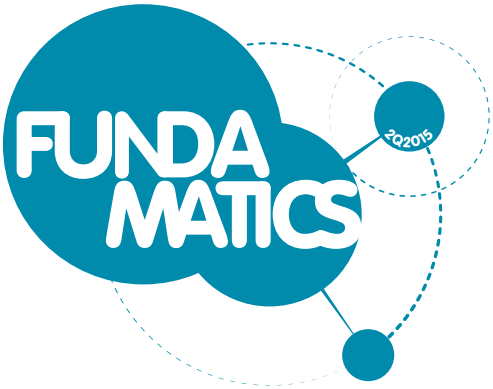

IITB-aa
IIT Bombay Alumni Association

Quarterly magazine of
The IIT Bombay Alumni Association

Contents


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From the Beehive

This issue of Fundamatics began the way all issues do – with the germ of an idea for a theme. The process in the middle too is always the same – the editor is akin to a browser with 50+ tabs open, all. the. time. Is it surprising then, that the magazine inevitably ends up buffering interminably?

We wished to do an issue on water as a theme. The fact that Monsoon was just beginning might have had something to do with our choice at that stage. There was renewal and hope in the air. The campus too was at its most sublime. But somewhere along the way, the theme of water could not be kept merely as a topic of intellectual inquiry but took on a more personal, closer-to-home cast.

The issue has seven scholarly water-themed articles that touch upon various aspects of the management of water as a resource. Yet, there is a limit to an anthropocentric discourse on water and we felt that it would be more meaningful to interconnect water with nature and to contextualise it to the campus and the still verdant ecology. After all, if there is a spirit to a place then anyone who has ever called IIT Bombay home would agree that it is inextricably linked to the twin lakes that span it like an exquisite garland. The lead piece of this issue thus is not from one of the water experts but by a campus amateur who writes passionately about the "Lake that Runs Through it" – the Powai lake.

The underpinning thread that ties the theme and this issue together is a concept of polarity and how water forms a part of the larger pattern of all things. A Yin and Yang of the natural order, if you will. It is an attempt to highlight that the issue of water needs to be cast beyond a reductionist science approach with a rational, mechanistic world view, to a more holistic science approach grounded by a nature-centered world view.

Think about it, water carries all life. It is also beyond time; for it carries within its flow not only the seeds of future life but also memories of past life. Yet, the minute we perceive water as a resource that should emerge at your command from a tap, we lose the mystique of water.

We attempt to refocus on this magic through "Of Rain and Other Precipitation" by Kadambari Devarajan which captures the other worldly quality of sitting at a window and hearing the drumbeat of the rains and watching droplets make their own pattern on the windowpane. There is a second piece from her and another from Sivaramakrishnan Sivasubramanian that celebrate the flora and fauna of the Powai campus, particularly its winged denizens.

When I write out my editorial it always comes with a sign – yet another issue is coming to a close. As I write out this piece, apart from the mandatory cup of Darjeeling, my only other companion is a spell of completely out-of-the-blue rain . A fitting closure. To sign out, I leave you with the memory of a beloved fragrance – Pertichor and hope that it serves as your companion while you read through this edition of Fundamatics.

Queenbee

A Lake Runs Through It

SHARBA SEN

Acknowledgement: Our sincere thanks to Prof. Arun Inamdar for providing the background information to this article.

I chatter, chatter, as I flow
To join the brimming river,
For men may come and men may go,
But I go on forever.

When I was in primary school, I read a poem about a brook that chattered merrily as it marked its course through hills and dales. The brook's merry song was punctuated with a somewhat cheeky refrain that went like this: *although the human life is transient, its own flow is perpetual*. This refrain stuck with me. With the naiveté of a school kid, I wondered how long would that forever be. In that moment, I also intuited the meaning of the word *eternal* – the brook would never cease to flow and would outlast generations of us.

With more years behind me now, I've come to realise that the natural world or nature is not exempt from the law of mutability that governs all living, breathing forms of life. It is a known geological fact that extinction is a natural process. Once formed all natural objects be it mountains, lakes, streams, or rivers do not stay the same. Like us, they pass through a cycle of youth, maturity, old age, and death. Water bodies, even the largest ones, slowly disappear as their basins fill with sediment and plant material. However, this natural aging of water bodies happens very slowly, over the course of hundreds and even thousands of years. Hence, the brook's boastful claim *"I go on forever."*

But the brook's song was sung before we humans started leaving our ugly footprints all over nature. Since then, we have distorted the natural landscape in a lot of ways: we have melted glaciers, reclaimed wetlands, drained rivers, razed mountains, deforested sprawling acres of woodland, quarried hills, and transformed nature into a useless sump in which to dilute our waste. That our actions have jeopardised the endless, blissful existence of an unknown brook is the least of our concerns because it feels more god-like to be able to engineer the destiny of the natural world, to dictate who shall live and for how long. So, we march on relentlessly replacing wild, raw nature with crafted, artificial landscapes.

Our own Backyard

For those of us who live in the IIT Bombay campus, we have a 520-acre lake in our backyard. This lake forms a soothing backdrop to all our academic, professional or domestic pursuits. We walk by it. We walk our dogs by it. We savour the fresh air that rushes into our lungs each time we take a detour through the narrow road that winds by the lake. While yapping with friends, we watch the sun go down from the steps of the Institute's guest house that commands a magnificent view of

the lake. We marvel at the bobbing silhouette of an occasional angler as he adroitly guides his tyre across the waters without paying any heed to the reptiles that lurk beneath. We delight at the sight of gliding eagles as they trace their trajectory over the lake soaring higher and higher. We photograph the lake and the wildlife that thrives on its waters. On clear days, we take pleasure in the glorious sunset that paints the sky above the lake in a riot of colours. And, in-between enjoying these idyllic moments, some of us wonder if the rapidly advancing beds of weeds will take over the lake, if the BMC's latest rejuvenation efforts will deliver lasting results or if the cattle that graze on the overrun shorelines will eventually displace the herons, kingfishers, cormorants, and crocodiles that call the lake their home?

Yes, at a little over 100 years of age the Powai Lake is already past its prime. With a fast receding shoreline, a heavily silted bottom and dropping water levels this lake in our backyard is at the brink of an ecological collapse and aging faster than it should. More worrisome is the fact that the lake is choking and possibly dying.

Is there any hope of eternity for the Powai lake?

How Green was my Valley

Yet even a few decades ago the condition of the lake was very different. Prof. Arun Inamdar of the Centre of Studies in Resources Engineering and an IIT-B alumnus, wistfully

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reminisces how in the 70s the lake used to be full brimmed and almost without a single trace of weed. When first visiting the institute as a prospective student from Sholapur, he recalls being awestruck by the undulating expanse of blue that lapped at the shores of the Institute. This blue panorama was a delight to his eyes, a *unique* spectacle for one who had been accustomed to an arid landscape. And, in that moment he made IITB his alma mater choosing it over other institutes in which he had been offered a seat. The institute's *technological prowess,* he notes with a quiet laugh, was a secondary consideration. It was the lake that made him fall in love with the Institute.

This youthful face of Powai Lake changed when the land around its catchment area was released for real estate development in the 80s and 90s of the last century. Until then the land which held the lake in its quiet embrace was mostly unspoilt except in patches where it was

tilled. Now the prolific builder arrived with his formidable arsenal of excavators, cranes, pavers and road millers to tame the wilderness. He started lopping trees, clearing the undergrowth, paving green hills and drawing out the water from the lake for the construction activities. Slowly but steadily plush residential towers reared their heads all across the landscape; towers that are coveted for their gorgeous view of the lake. Next, roads were developed to support the influx of people in this area. And, like this one act of construction led to another converting the Powai region into an *upmarket commercial and residential hub.*

The Powai Lake still stands at the centre of all this new grandeur. In fact, it itself is the centrepiece. It still continues to mesmerise the old and the new who live around it. Birds still fly across its horizon. Crocodiles still swim in its waters. The sun still sets on its horizon. But, there's something else happening too. The once scenic lake is today smothered by floating beds of hyacinth and slimy green algae, caked with silt, and saturated with pollution. In comparison to the full-brimmed spectacle of the 70's, the lake is today a mere shadow of itself.

How did the picture change within such a short span of time?

Standing on the Brink

Of all the different factors that have contributed towards the diminution of the Powai Lake, Prof. Inamdar considers silting and pollution to be the worst culprits.

When the land around the Powai basin was reclaimed and built over, large swathes of woodland were cleared to make way for new buildings. This deforestation accelerated soil erosion around the margins of the lake, the bulk of which was deposited at its bottom. In addition, the silt churned by the construction sites also found its way into the lake making it shallower and reducing its intrinsic capacity for storing water. Prof. Inamdar cautions that a rise in the height of a lake bed can have several negative ramifications. First, aquatic life depends heavily on the supply of fresh water that exists in lakes; reduced volume of

'..but why are they spending a fortune on this technology for promising the lake-bottom view, when they can always see it here for free..'

water means less dissolved oxygen and less living space for the biota. Secondly, a rise in the floor level also means quick overflow that can potentially lead to flood conditions. As a geologist would explain, apart from anchoring soils, a forest cover acts as a sort of sponge that releases water at regular intervals. The loss of forest cover creates impervious surfaces allowing more runoff to flow rapidly into streams, rapidly elevating water levels and subjecting downstream settlements to flooding. And this is exactly what had happened in 2005 when Powai began to overflow and discharged thousands of litres of water into the Mithi River.

During the dry season, the scenario in the Powai basin is completely different; areas downstream of deforested land are prone to months-long drought. This is because the streams of natural runoff that would earlier flow into the lake have been either cut off because of the development work or are bringing less and less water to the lake each year. That this rain-fed lake is gradually shrinking is perceptible not only from its fast reducing shoreline but also from the way its waters hit the bottom within months of monsoon turning vast stretches of the lake into cricket ground or grassland for cattle. The lake is therefore impacted in two major ways: on one hand, sedimentation has decreased its water storing capacity; on the other hand the sources of replenishment (in the form of monsoon rainfall or natural run-off) for this lake have dried up due to the heavy deforestation and urbanisation in its catchment area.

At a little over 100 years of age the Powai Lake is already past its prime. With a fast receding shoreline, a heavily silted bottom and dropping water levels this lake in our backyard is at the brink of an ecological collapse and aging faster than it should. More worrisome is the fact that the lake is choking and possibly dying.

Another huge source of worry is the pollution. This presence of pollutants in the lake is evident from the colonies of water hyacinth and other aquatic weeds that have taken over vast portions of the lake. Not only does the process of development contaminate our environment but the *developed* land in turn becomes a perennial source of pollution both by its structures and the lifestyles of people living in them. In the instance of the Powai basin, the act of development has created new pockets of habitation that now routinely release sewage and industrial waste into the lake; a problem that is aggravated by the declining vegetation cover in the surrounds of the lake. The positive benefits of shoreline vegetation go beyond preventing soil erosion

'Powai Lake Cleaning!'

or maintaining the precipitation levels in a region. The natural vegetation cover around a water body also acts as living filters of pollution by capturing soil sediment, chemicals and other pollutants that may be present in the runoff that flows into the lake from the human settlements on its banks. Reduced shoreline vegetation allows the runoff to enter the lake directly without undergoing this natural *filtration* process. The pollutants that enter the lake thus disrupt the natural balance of the water creating an environment suitable for invasive aquatic plants.

The Road Not Taken

When faced with the imminent threat of an overwhelming environmental issue such as a dying lake, the tendency is to engage in a blame game by either pinning the onus on a group of individuals or by attributing the accountability for ecological degradation to an institution. Out of despair, we censure the real estate developer for marauding the virgin land or the hotel owner for flagrantly violating the pollution control guidelines; lambast industries for not treating their waste or the Municipal Corporation of Greater Mumbai (MCGM) for not trying harder. But that hardly takes us anywhere and certainly does not save the lake. At the end of day, we are all collectively responsible because this defilement affects us even when we have no personal accountability.

However, in the case of Powai Lake indifference or lack of awareness is not an issue. Strange as it may sound, the stakeholders of the Powai Lake — the developer, the resident, the industries that draw water from the lake, the IITB Heritage Foundation, the BMC that owns the lake — are not entirely apathetic to the plight of this ailing lake. We all care for the lake to a greater or lesser extent. How else do we explain the money worth lakhs of rupees that the BMC has liberally poured into the lake or the volunteering work that has been done from time to time to cure the ailing water body? In fact, Prof. Inamdar takes a moment to recall the effort made by the IIT-B Class of 1980 to rejuvenate the lake. Yet surprisingly we have very little to show for our labours apart from a well-paved promenade along the shore, a couple of parks, and a musical fountain at the lakefront that is played twice each evening.

The correct question to ask is not if we are interested in saving the lake but if our endeavours match the scale of the problem? Are we making a sustained effort in the right direction? And, most importantly, are we thinking and working scientifically?

Prof. Inamdar, who has closely monitored the several rejuvenation attempts made for the lake, points out glaring gaps in what he describes as “staggered and primarily aesthetic treatment” of the lake. For instance, when the Class of 1980 realised that with the funds they raised couldn't have made any impact on the lake, the money was reallocated to beautification of the lake road inside IIT-B and the creation of Kshitij - a garden behind the Convocation Hall. But, argues Prof, Inamdar, cosmetic changes around the lakefront are not going to help as they derive their value

from the lake. If the lake dries up, the musical fountain, the parks, and the promenade will be worthless.

On the subject of water hyacinth, Prof Inamdar thinks that no matter how many times we clean up the water hyacinth infested areas of the lake, they will return because we are not inhibiting seed germination – the achievement of which will require some methodical planning. The sporadic removal of water hyacinth is like granting temporary relief to the lake or removing a cancerous biomass without curing it of the malady. Getting to the root of the issue (both literally and figuratively), Prof Inamdar continues, the dense, floating mats of hyacinth are flourishing due to the rampant pollution that creates an ideal habitat for these weeds. The rampant pollution is the result of direct disposal of untreated filth into the lake from the surroundings. These weeds will not go away as long as the lake waters remain polluted. We may recall that Powai Lake which had been created in 1891 to supply drinking water supply for Mumbai was declared unfit for this purpose very early on in its history. In fact, back then, IIT-B was one of the major culprits dumping its untreated sewage in the lake. This was even before the start of quarrying and constructing on and around its catchment area. Since then the water of the lake has been suitable only for non potable purposes such as gardening and industrial use. To heal this long-suffering lake, we have to focus our resources on eliminating pollution, which is at the root of all its troubles, in a more systematic way.

What is the way out? According to Prof. Inamdar, a more rational approach is to create a buffer zone (or natural strip of vegetation) around the lake that will help to minimise the adverse influence of residential, commercial and industrial pockets that surround it. Without such buffers, Prof. Inamdar maintains, residential and industrial neighbourhoods will continue pouring sediment, fertilisers, pesticides, and many other pollutants into the water body. Another advantage of having buffer zones, he underlines is that they limit the extent of construction thereby also indirectly controlling soil erosion and sedimentation that result from it.

Another remedial measure that the professor strongly recommends is the setting up of a STP to remove contaminants from sewage at the source of pollution before it is released into the lake. This ensures that only environmentally safe water flows into the lake. Another added benefit of this treated water is that it can augment the scarce natural runoff that reaches the lake these days. In fact, Prof.

Inamdar points out that once there used to be a STP on our campus. But this STP, which was located behind H4, was woefully undersized and most of the time not working. Moreover, its location was at a higher elevation than most of the campus due to which much of the sewage rarely reached the plant. The current practice is to redirect the waste water into municipal sewers for disposal elsewhere.

Simple as these solutions may sound, their methodical implementation will take leadership, vision and, as Prof. Inamdar puts it, political will from across the spectrum of stakeholders who stand to benefit from the lake in one way or the other. It also means making a quite a few tough choices and we all will need to sign up for it.

Down to earth

The moot question is whether Powai basin should have always remained a stretch of wilderness? Probably not. The pressure on land is evident to us. But then should we readily assume that nature is something to exploit whether as a material resource or as a backdrop for our residences? Not necessarily. We must understand that "the earth is not as vast a place as we imagine it to be; not boundless in its bounty. It has a system based on intricate relationships between the living and the non-living, renewable and non-renewable resources. And only some of the components of the system cannot compensate for the whole. Today's realisation is to nurture and enhance synergy to the extent that what you consume in your life-time enhances the quality of your life, but still leaves enough for future generations."

In other words, a sympathetic engagement with nature need not threaten the pace of our development. When we start respecting the delicate web of life that interconnects all of us, the word eternal acquires a whole new layer of meaning beyond its lexical connotation. In nature, eternal is not just everlasting; it is about meeting our own needs without ruining the chances of future generations to do the same. That is how we can all participate in the eternal life of nature.

If we don't heed now, very soon the lake in our backyard will be gone without even a bog to mark its grave. It is for us to breathe life into this dying lake and return its ecosystem to a more desirable state.

The gift of eternity will follow.

Sharba Sen

Sharba is a trained technical writer. After spending a decade writing software manuals, she switched tracks and joined her dream job of working on the production of a magazine. Now a "Newbee" at the Beehive, she assists Queenbee to churn out the Fundamatics issues.

Of Rains and Other Such Precipitation...

KADAMBARI DEVARAJAN

I remember reading this lovely book about a man whose quest was to follow the course of the monsoon in India- 'Chasing the Monsoon' by Alexander Frater. He starts in Kerala at the advent of the monsoon and "chases" it just short of the Seven Sisters (the North-East of India, for those of you weak on sobriquets).

This was a few years ago, by which time I had developed a plethora of "rainy-day fantasies". Some of them have come true and some others, repeatedly so. Sit by the window sill, either at a table near the window or on a bed suitably arranged (this of course requires appropriate foresight when getting the house furnished, but that's another tale), leaning against a big bolster (if applicable to the seating), sipping deliciously warm lemon tea or cocoa (this was before my obsession with herbal teas of all consistencies and colours) and reading a book. Nothing even comes close to this feeling.

This fantasy would, of course, get better - simply intersperse the reading with moments of thoughtfulness (or thoughtlessness, as the case may be), staring into the rain as though it were the object of your doctoral thesis, not to forget absentmindedly biting into crisp, hot pakoras. There would be variations of this fantasy - involving fireplaces and rugs and what not, for the curious amongst you, but we'll not be covering them just as yet. The mood and setting - just perfect for some Simon & Garfunkel, vasantha or amruthavarshini. And, although I'm a great lover of science-fiction, this fantasy requires something more attuned to the situation. Like M&Bs (oh, c'mon - don't be judgemental!), Wodehouse, Gerald Durrell, Dave Barry or James Herriot. Terry Pratchett or Douglas Adams could be squeezed in perhaps, but trust me, nothing beats some romance/humour.

And then, there are those books that do NOT depend on the weather (even if their titles mention something related) - no one would want to day-dream and sit around enjoying some atmospheric phenomenon after reading 'Everybody Loves a Good Drought'. The reader has to be one cold person to not feel like doing something useful! I was inspired enough to seriously consider following P.Sainath's footsteps and pursue "his" kind of journalism ... but we're digressing and that's another rainy-day story (old-and-now-obsolete pun)!

Another fantasy that had caught my fancy was of course actually doing what Alexander Frater did, and following his wet (pun unintended) trail. I will, maybe, do that. Sometimes. I do have a knack for arriving in the worst possible weather at many places. Take the past year alone - I travelled by sleeper class train from Madras to Delhi during the height of summer, reached Bombay from Madras when the monsoon was bent on impressing me with "quantity", landed in Chicago in peak winter (when I'd never in my life seen

Image credit: Image is sourced from https://unsplash.com/

sub-zero) and got back to Bombay in time for yet-another-monsoon. And oh, I also managed to visit Seattle during its "rainy season" (so to speak) and Texas in summer.

It has been very, very interesting and a lot of fun. I somehow don't remember spending too much time gazing out of glass panes, enjoying the snow. It was nice, especially walking during a snow-fall (read snow-FALL, not storm, or blizzard), covered from head to toe, holding hands with your loved one, listening to the almost-silent falling of the flakes and feeling them gently plop on your face ... but I somehow never got to watching the snow flakes, reading, and all that jazz. On the other hand, I truly don't enjoy walking (or doing anything even remotely outdoorsy) during a downpour. Nope, that's not for me, especially in India! It is quite nice walking in a drizzle, but not when it's pouring cats-and-dogs. I remember how I'd have my raincoat on AND an umbrella to go anywhere - it's not as much fun as watching from the other side of a window! And driving/riding is not much better, but that's just because of the roads potholes.

I have also had a lot of fun in the rain. There's NOTHING like playing football when it's pouring. At least, that was the case for me at the age of 13.

And, if you're in Bombay during the rains, it is sacrilegious to not go on a monsoon trek. There are places in Bombay, or minutes from it, that are fantastic to hike/trek. Moreover, there are hundreds of forts that could be covered in these monsoon hikes for those looking for a taste of history. There are an incredible number of trekking outfits that go there weekend after weekend. For the more adventurous amongst you (yeah, that's you, the person enjoying adding buckets of water to torrential rain), I would recommend waterfall rappelling or abseiling. Recently, I made a waterfall rappelling trip to a place near Bhivpuri, some 80 km from Mumbai.

The falls were about 60 ft. highand considered to be amongst the easier to rappel. It was my first time waterfall rappelling, although I have done some rock-climbing and certain

Image credit: Image is sourced from https://unsplash.com/

other drier-forms of rappelling. It was not really that easy and I slipped and dinged myself against the rocks more than once, until I realized the key was "technique, technique, technique". You need to be at right angles to the wall, legs wide, taking small steps backward with the help of ropes that involve use of both hands. And oh, tip backwards but don't go overboard (pun unintended) - you'll just topple backwards! AND, keep a distance between the feet - bring them close and you'll start oscillating like a pendulum! Instructions such as these are a mouthful for an amateur to handle, but after learning to pick myself up after my first nasty fall, there was, the proverbial, no going back. But mind you, it was exhilarating.

You can take your time going down (it's not as bad as it sounds!) and stop and relish the view from midair. As you get near the bottom, the head-rush and adrenalin-high are unmistakeable. The safety measures were in place and at no point did I feel really vulnerable or precarious. Very, very importantly- they didn't make anyone sign a form saying "We're not responsible for accidental death or damage"blah, blah blah...(or something along those lines) and THAT was a huge relief. To start something after signing stuff like that IS scary and very weird!

Again, I just meandered off! I started typing this listening to the rain and decided to write (for a change, rather than read). There were also some personal storms raging, and simply sitting and writing brought about a relaxing lull. As you can now surmise, I like the rains. Over the years, I have also learnt to accept and enjoy summer and winter and monsoon, sunshine and snowflakes and everything in between. I guess that's the way it is - everyone will enjoy the rain, as long as they're not hurrying for an appointment, trying desperately to catch an auto, dressed just seconds ago in crisp white!

And, on that philosophical note... 💧

Kadambari Devarajan

Kadambari Devarajan is an engineer-turned-ecologist (computer-scientist-turned-conservationist, if you will) and is currently a graduate student at the National Centre for Biological Sciences. She lives to eat, travel, and read, not necessarily in that order. She is a compulsive reader, unpredictable writer, data geek, insatiable traveler, adventure junkie, highly-excitable photographer, ardent naturalist, borderline twitcher, enthusiastic FOSS evangelist/user, and food fanatic.

On the Powai Lake

A. BIRD

Be the rising or the setting sun
birds seem to be having fun

A cormorant sun bathes while a shrike
tries new shades

A stilt with legs thin
looks in the shallow for fin

As the Ibiss's glide in a vee
quacking, whistling ducks wonder,
"how many are we?"

The kingfisher seems all blue, but dives
in a split second;
it makes fish run for their lives

Herons, purple and grey,
use their wingspans
to impress the lady clan

Terns fly, turn, fly and turn
wonder why they are avoiding a sun burn

While the koel coos and the cow moos
a school of parrots is set loose

Image credit: Image is sourced from https://unsplash.com/

Hawks sit brooding, catch prey swooping
wonder where they got their schooling

There are crocodiles I hear
should we fear? Oh yes! if we or it comes near

eagles soar, scan the panorama
"Is there a new drama?"
Engines cut and uproot,
axes go 'hack, hack'
the lake wonders who is this quack

Folks come, sit, talk and see
do they ever wonder,
"Is the lake part of us, or are we?"

Acknowledgement: This poem was originally published in Anniversary issue of Raintree (Issue 6 •March-April 2010).

Thara Ticket at the (Probably) Thakara Theatre

KADAMBARI DEVARAJAN

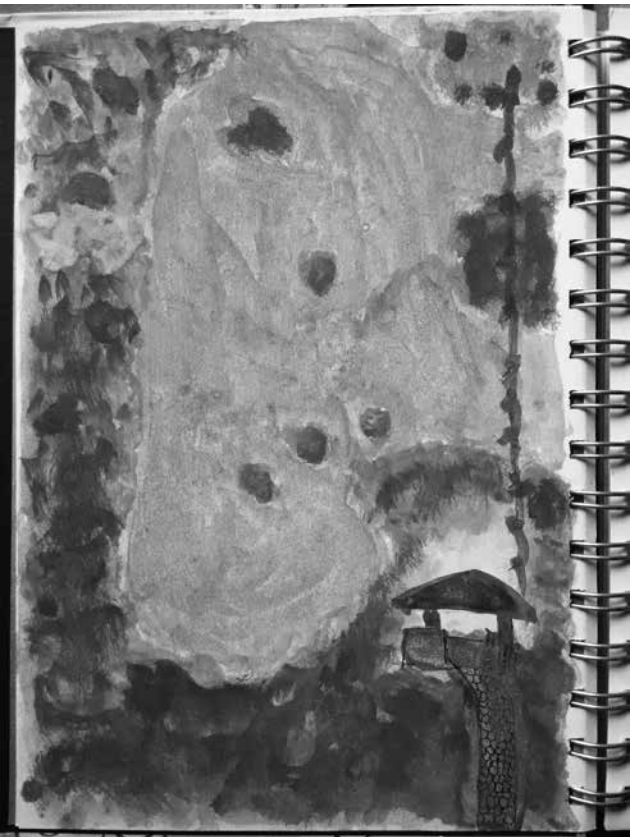
There is a little shed on a tiny sliver of land jutting into the lake. I'm no metallurgist, so excuse me if I take it to be made of tin, or thakaram as it is called in Tamil. That paints a nicer picture for the romantic in me, you see. This shed is unlike any other, or so I tell myself. It is an amphitheatre where such drama unfolds, the likes of which even Bollywood could not have seen. So pardon me for calling dibs on a permanent seat on the floor. The tharai ticket, as we Tamilians like to call it, used to be the cheapest ticket at the local cinema, typically on the floor, right in front of the screen, and affording the spectators (usually children) the simple pleasure of squatting, and the supreme luxury of erupting in a raucous jig at the slightest excuse. Sadly, this disappeared with the advent of multiplexes, aerated drinks, and air-conditioning, not necessarily in that order.

Anyway, this little tin shed on Powai Lake has played host to romances, tragedies, thrillers, mysteries, and everything in between, but with some serious twists. Firstly, the actors are not always human. And secondly, it is all spontaneous and impromptu, kind of like improvisational stand-up comedy – the blink-and-you-shall-miss kind of action that goes against the theatre norms of scripted films, re-runs, show-timings, and advertisements. The kind that one is unlikely to ever find on DC++. Lastly, it is always, always free (as in "free beer").

Let's start at the beginning. My love affair with the Powai lake started about six years ago, during my first ever Mumbai monsoon. With tangled vines and tall trees in varying shades of green, drip stains on buildings great and small, resonating bird calls, and many a fall on the slippery stones of the Infinite Corridor, I was welcomed into the IIT Bombay fold. Is there anything like some rain to bring out the colors of the forest? That monsoon on campus was sheer magic, as I settled in to explore what I could of the institute. The first stop of the campus' tourist circuit was the lake, of course.

There was a sign warning folks against proceeding beyond the gate running between Jal Vihar and the Powai Lake after dark. Here be marauding leopards, consider thyself forewarned. Or something similar. Which of course meant that I absolutely had to see what was beyond those gates. I played it by the rules (don't judge me, I was still a campus noob, remember?), and one Saturday morning when sunshine had won the peek-a-boo with the clouds and there was a brief respite from the downpour, wound my way through the lovely trail that culminated in the cutest little shed. Over the years, I was to return and re-discover the shed, time and time again. The shed has seen many of my moods and phases, laughter, tears and tantrums, walks and talks.

There was the brief jogging phase, which did not last very long considering the com-



A page from my field diary

A purple swamphen

mute between the hillside and the lakeside. Then, there was the birdwatching phase when I would walk the lakeside stretch, pretty much end-to-end, but almost always starting in the middle, near Jal Vihar. The purple swamphens will take the trophy for the most "First Bird of the Day" records. Giving them stiff competition for the title are the cattle egrets. The egrets may even be donning their breeding plumage, looking slightly silly in their dirty yellows, as opposed to the regular regal whites.

Turn left and head towards the Temple cosily ensconced in one corner of the campus. Did you hear the shrill squawking of the rose-ringed parakeets? Whether flying overhead or feeding off a fruit tree, they are quite the party-goers. Thanks to their green good looks and their ability to mimic human speech, they are unfortunately popular as pets. What is it that makes people want to cage a bird, I could never understand!

Moving on, one is likely to see a white-breasted kingfisher, perched on a slender branch, ready to nab a fish any minute now. There is no action movie in the world I would trade for the seat-of-the-pants thrill of watching a kingfisher fishing. No, seriously. Especially if it were the not-so-common and ineptly named common kingfisher.

Some red-vented and red-whiskered bulbuls would be shuttling between the shrubbery, in total disregard of all and sundry. That dab of yellow squinting between the

An Indian grey mongoose

A barn owl

A pair of greater painted snipes

foliage might mean a golden oriole perched on a branch. Then, there's the most dapper little bird of them all, the oriental magpie robin. Quite a name for a small bird, if a prim-and-proper-looking one. Do not be fooled by his black-jacket looks – he can be supremely entertaining, changing his call every so often, mimicking anything that catches his fancy, trying to lure the lurking female, who in typical bird fashion is frankly quite drab in appearance.

I would be desperately trying to identify the warbler in the bushes, when the booming, low coop-coop-coop of the greater coucal clashes with the metronomic beat of the coppersmith barbet. The former, easy to spot and looking like a glorified crow, while the latter, breathtakingly colorful if a tad harder to spot through the foliage. To me, the only bird seen on campus that can usurp the barbet, color for color, is the Indian pitta. This orchestra would be further amplified by the melodious cooing of the koel. Suddenly, the forest would resound with the cacophony of the common hawk cuckoo, affectionately and aptly called the brainfever bird. This might possibly shock the other avian critters to a few moments of pregnant silence before the forest returns to normalcy. The super-shy white-breasted waterhen will likely sieze this opportunity to make a dart for safety among the reeds and weeds along the lake.

On a lark, I would make a U-turn somewhere on this stretch, magnetically drawn towards the aforementioned tin shed on the other corner of my yellow brick road. This time, retracing my footsteps, I focus on the lake. This has rewarded me on numerous occasions with spectacular chases that would put the makers of the Fast and the Furious series to shame, ranging from an osprey swooping down to catch what looked like a massive catfish in its talons to a marsh harrier warding off a black kite from some spot in the hyacinths on the lake's edge. The birdwatching might briefly take the backburner when a

Red-wattled lapwing chick following its parent

A mugger in the Powai Lake

mongoose crosses the road or a monitor lizard clambers up the palm tree or a common garden lizard basks in the sun, but not for long.

Crossing Jal Vihar, one can watch swallows on the palm trees, cormorants spreading their wings in the sun for thermo-regulation, spot-billed ducks and lesser whistling ducks paddling hither-thither, pond herons sitting boringly still, ibises wading between the hyacinths, and jaçanas both bronze-winged and pheasant-tailed gliding like ballerinas between the leaves floating on the water. I amble across the sunbird patch ignoring the noisy babblers flitting about and stop at the flycatcher patch which today decided to reward me with a magnificent male Asian paradise flycatcher, breeding plumage and all. Watching it to my heart's content, I trudge on before stopping at the intersection that leads to the little tin shed. In the past, this area has pleased me with Indian grey hornbills and spotted owlets and orange-headed thrushes and flameback woodpeckers. Nothing today and so I continue, finally reaching the shed. Thankfully there is no one else around and I can watch the terns flying about in peace.

My favorite time to be at the shed would have to be dusk but unfortunately that is when it is most crowded. During the day, on some days, one might see the occasional couple canoodling at a private rendezvous, or a fisherman about his work paddling in the water with a tyre for a flotation device. But come evening and the place is swarming with twos and threes and droves of people, swatting mosquitoes and scratching insect bites. However, some of my favorite birdwatching sessions have happened despite the crowds. Like a few years ago when I watched a pair of greater painted snipes go about their business, day in and day out for a month, on a tiny island just off the shed. And the number of times I have seen a red-wattled lapwing go berserk on another little island, weirdly drawing more attention to her tiny chick, rather than away from it! And the rare occasions when I saw mugger crocodiles lurking quietly in the murky water, just their snouts visible.

The mention of crocodiles reminds me of an anecdote heard at a dinner with friends a few years ago. The legend goes that many, many years ago, a young student (who is now a faculty member here and shall hence not be named) would religiously swim across one of the triumvirate of lakes in the vicinity of the campus. One fine day, while swimming towards the target island, the person saw what was assumed to be a rock on the island move, only to realise that it was a crocodile! I wish I could say that the swimming ritual came to a standstill and the person shifted to the less exciting option of using the Gymkhana pool, but apparently students continued to swim even after this incident for a few years.

With tangled vines and tall trees in varying shades of green, drip stains on buildings great and small, resonating bird calls, and many a fall on the slippery stones of the Infinite Corridor, I was welcomed into the IIT Bombay fold.

These days the only brave souls who venture into the lake are the fishermen who appear at odd times, bobbing about with just their head above the water, and using a tyre to keep afloat, whilst trying to fish, possible remnants of a not-so-successful fish culture project started and abandoned decades ago. Reading reports of fishermen getting mauled by crocs in the lake, on and off, I find it sad to think about them risking their lives on the job.

Returning to the lake, standing by the boat jetty in front of Jal Vihar, one can think pensive imponderables. Like how lucky one is

An osprey with its catch

to have a view to die for just there, while folks pay a pretty penny at the fancy hotels across the lake for a room with a view (honestly, I think ours is better, and not just because it is free). Like how the view is worth the killer mosquito bites and the risk of malaria. Like how the hyacinths and weeds have ballooned and taken over the lake resulting in a sadly shrinking lake. Like who is being subjected to a volley of barks by that dog on the leash. Like the sheer number of feral dogs on campus. Like how many leopards could there be on campus. Like why I am yet to see my first leopard, despite the late night walks and occasionally setting camera traps for the big cat. Like how I hope my thara ticket at the thakara shed never disappears ...

Kadambari Devarajan

Kadambari Devarajan is an engineer-turned-ecologist (computer-scientist-turned-conservationist, if you will) and is currently a graduate student at the National Centre for Biological Sciences. She lives to eat, travel, and read, not necessarily in that order. She is a compulsive reader, unpredictable writer, data geek, insatiable traveler, adventure junkie, highly-excitable photographer, ardent naturalist, borderline twitcher, enthusiastic FOSS evangelist/user, and food fanatic.

Reminders on Treading Lightly

In the December of 1989, an international pharma conference and exhibition was held on campus. The organisers went on a rampage – wanton felling of trees and burning of undergrowth – to provide parking space for the participants. Anguished by this, some students photographed the massacre and put up posters all over the campus. Next day, a spontaneous morcha originated in one of the hostels. More students joined it along the way and about a hundred students, carrying these posters, marched silently into and out of the Convo during the inauguration of the conference.

This shook up the institute authorities and the organisers and some attempts were made to remedy the situation. However, these were merely cosmetic. The rapid degradation of the campus environment and apathy of the institute gave birth to an independent student newsletter, **The Drongo**. *In its first issue, published in April 1990, it said:*

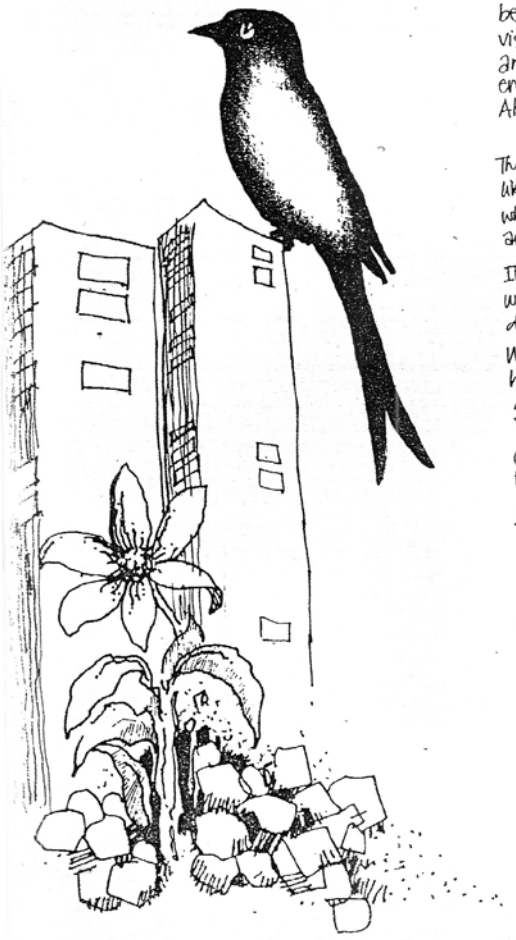
> *This newsletter attempts to gather like-minded people into a cohesive group, which will analyse our current situation and suggest practical solutions. It attempts to serve as a watchdog, which informs the campusites of ongoing developments/degradations. We also aim to create issues (yes, they have to be created) which, in turn, may galvanise the administration into action.*

Tree Plantation on Vihar Hill, from the first issue of The Drongo, describes the efforts of a group of students who planted many trees on the hill behind H3-H4. While the institute authorities were smug with photo-ops at Vanmahostavs, this group not only planted saplings but watered them and cared for them throughout the year. In the next 2-3 years, more than 1,000 saplings were planted. The project was very popular and every evening you would find students lugging water up the hill to water their favourite patch. In spite of the grazing and frequent fires, many saplings survived to become healthy trees.

Stumblebee

THE DRONGO

NEWSLETTER



The time has come for us to look back and into the future of our campus.

Various things such as buildings, roads, sewage treatment plants and a disappearing heritage & culture.

TECHNIC/TANTRA have traditionally avoided or ignored such issues, partly because the changes were not so visible a few years ago, and the pressures on our immediate environment were few. Also, it does not make racy reading.

This newsletter attempts to gather like minded people into a cohesive group which will analyse our current situation and suggest practical solutions.

It attempts to serve as a watchdog which informs the campusites of ongoing developments/degradations.

We also aim to create issues (yes, they have to be created) which in turn, may galvanize the administration into action.

Of course our own motto will continue to be: Think globally, act locally.

So for the second half, let's gather at

RAINBOW
Monday 16th April '90
6:00 PM.

Contributions/ideas/suggestions/responses are most welcome, and may be handed over to:

CTARA/GRA
Shirish Waghulde, H7, 229/Metg. Engg.
Milind Schavi H1, 182/Comp. Sc.
Raja Mohanty H1, 179/IDC
U. Subbaraju H1, 81/CTARA.

P.S. The international earth day is on the 22nd April. Watch out for further notices.

Tree Plantation on Vihar Hill

(REPUBLISHED FROM DRONGO)

"I love nature very much and if you know how much I love it, come to my home and I can show you 142 types of cacti which I have been growing in my backyard," says one industrialist cum nature lover. "My whole family loves ecology and wildlife. We have a number of animals on our farm and we all love them", says another man who is a big social worker cum industrialist.

Some people thus try to prove their love for nature, ecology, wildlife, etc. when you question their actions that are quite damaging to the environment just beyond their farmhouses and backyards. You go to these people with all the sorrow and anger and you see these people proclaiming how much concern they have for trees and animals. But you can actually see that their love is not genuine. They try to somehow evade the issue and pacify us. In order to kill time, they talk about the technicalities of lawmaking, the difference between micro and macro environments.

Writing the details about the incident which led to some of us meeting these people will take a lot of time and space. Anyway these details and these people are not important here. What is more important is to look at the attitudes these people have. When we look at ourselves deeply, we realise we also have these attitudes these people have. We throw our garbage into the streets and keep our houses clean. This way we prove how much love we have for cleanliness. If someone questions still, we can hide behind things like *micro-environment* and *macro-environment*. Unfortunately this sort of behavior has caused a lot of damage to the environment around us. We have become highly insensitive to this damage. The dying Powai Lake on one side and the degraded hills on the other side of our campus tell everything about us: our intelligence, our sensitivity, our attitudes.

I request the reader to forgive me for the digression. We have been ceremoniously doing things like removing water hyacinth from the lake and planting trees on hills. But things remain the same and usually get worse. We (students, faculty and staff) need to understand the causes behind it and find out whether we are really interested in protecting the things around us.

One day we came to hear from a very big person the need to have a *Vanamahotsav* on our campus. He said, "We will have a *Vanamahotsav* on our campus." This statement was immediately followed by something like "we will have a rose bed here and a rose bed there". This is the sort of loose thinking we have and it gets reflected in our inconsistent actions which ultimately end up in things like the present state of the Powai lake. Now it is very important to realise whether we are really interested in improving the things around us. After the positive or negative answer, we had better stop talking hypocritically.

Talking about nature, ecology, environ-

Image credit: Frits Ahlefeldt http://landscapesofunderstanding.com/photo/284/Book-tower-experts-Color-illustration.html

mental problems, and criticising people and incidents is very easy and sometimes very entertaining. But there is another thing which is easier and extremely enjoyable. That is planting a tree and taking care of it. One learns a lot of things in life from a tree. Every new bud, every new leaf, and every new branch tells you something. You realise your place in this world and your role in taking care of your place.

For eight months in a year, our hills are ugly. Only during the monsoon is the hill green. In October the green grass starts dying. In November, it is fully dry. In December, one day the hill suddenly turns black. Everything on the hill is burnt out. Then the black hills slowly fade and keep waiting till mid June for the monsoon. With the monsoon they suddenly turn green and remain so for another four months.

Over the years we have allowed heavy deforestation to take place on the hills and now they are completely barren. Now only grass grows there during the monsoon. Looking at these degraded hills, some of us felt that we should do something. We didn't plan anything in the beginning, but with enthusiastic participation of like minded people, we have planted 200 saplings on the Vihar hill.

There were many problems that we had to encounter. When there were too many cattle grazing on the hill, we made friends with the

We throw our garbage into the streets and keep our houses clean. This way we prove how much love we have for cleanliness.

grazers and they prevented the cattle from trampling our saplings. Then the grass around grew taller than the saplings. So we had to remove the grass around them. At the end of the monsoon, we realised the fire problem. So we became grass cutters and removed all the grass in the entire area where we had planted the saplings. After doing all these things, the plants were asking for water. Then we started watering the plants – filling jerry cans with water from the lake, carrying it to the top of the hill, and watering the plants. With regular watering the plants were growing healthily and vigorously. Everything was peaceful till the first week of December. Suddenly on a Sunday morning, fire engulfed the hill. Our saplings were not burnt (because we had cleared the dry grass around them) but the intense heat from the surroundings damaged them heavily. It was a very sad scene. But we didn't lose our spirits. The watering continued and the plants started growing again.

We shall be watering these plants till next monsoon. Next monsoon we plan to plant about 800 saplings which are growing in our

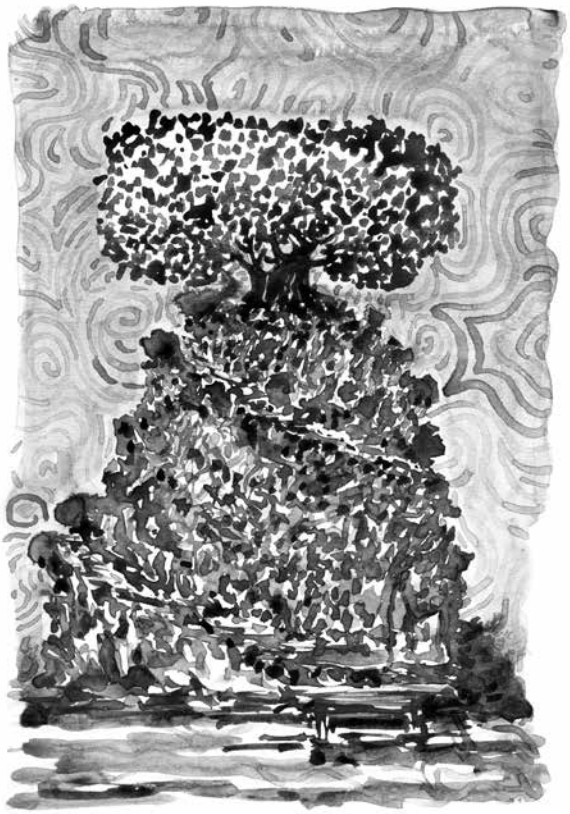


Image credit: Frits Ahlefeldt http://landscapesofunderstanding.com/photo/1240/Tree-on-a-hill-watercolor.html

nursery. What we could do this year was very little. At present about 85 saplings are growing on a small patch of land on top of the Vihar hill. But this first experience has taught us lot. Now a lot of people are taking care of the plants.

There is not any dearth of people's participation. Basically, most of us have an inherent love for trees. But for protecting the hills from degradation, the Institute has to take serious responsibility. It has to take conscious and consistent efforts in afforesting the hills. We are very fortunate to have these hills on our campus and we are responsible for the terrible degradation that has taken place. The same applies to the Powai lake as well.

Talking about *Vanamahotsavs* is not of any use unless we are able to properly understand the present state of affairs. Last month, a friend and I attended a lecture given by a great professor on environment. Impressed by his sensitivity for the environment, we went to him and started talking about our environmental problems in general. After some time, we were talking about our own environment. Suddenly the host professor came and started listening to us. But we could see his irritation. He felt that we were discussing silly things. He said, "Sir, in India, all sorts of people come and talk about all sorts of problems. Actually wherever you go, you will find only problems. Now, why don't you please talk to an environment modeling expert whom I have brought with me. It may be better that we concentrate on modeling." Talking about our Powai lake and our campus hills is talking about "all sorts of problems" for one of our own faculty. He went on explaining the importance of modeling. It was terribly shocking. There was a feeling of hopelessness.

The dying Powai Lake on one side and the degraded hills on the other side of our campus tell everything about us: our intelligence, our sensitivity, our attitudes.

But the plants are growing well on the hill with all the difficulties such as fires, the scorching heat and the barren surroundings. Should we give up hope?

Varsha Stuti - The Genesis

JANAK DAFTARI

It's monsoon magic show-time again folks, evoking some poignant memories of one's salad days on the campus. Memories of winds rustling through the trees, gurgling brooks, cuckoo concerts and croaking frog competitions (which sometimes even hostel chatter resembled). Memories of missed lectures because it was raining heavily (or not, sometimes). Of course, there was the pitter-patter of raindrops delivering mellifluous surround sound. And the pounding crescendo of heavy showers accompanied by the whistling winds. There was an innocent, wicked joy watching umbrellas turn inside out to become rain harvesting structures. And the superior, smug feeling generated watching the muggoos returning from lectures to the hostel like wet rag dolls.

Rains have been traditionally accorded god-like respect in our country since much of our agriculture (and rivers) is rain-fed. It's a well established phenomenon that consumer goods' managers rubbed their corporate hands with glee when the monsoon was bountiful. There are many, many rituals and celebrations propitiating and welcoming the monsoon in the villages. More importantly, systems had evolved over centuries to harvest the rain precipitation in consonance with the local geo-morphology. This has been our hoary traditional mechanism for drinking water and food production, sustainably using the natural resource of water. Alas, urban development of late has always been at the cost of our water resources and conservation structures. However, though depleting groundwater and polluted water bodies bode ill for the nation; this is not the subject matter here.

Personally, was seduced by the monsoon magic right from the first day on the campus. After emerging triumphant (albeit battle-scarred) from JEE1966 slog, moved in to H5, complete with a lakeside view and attached toilet. The Powai lake, surface rippling with raindrops in myriad patterns unsullied by the dictates of Drawing 101, presented a fascinating scene. The advancing sheet of rain across the wide expanse of the lake was visible right from the L&T end until it hit the hostels. This, of course, necessitated lying prone on my bed and gazing out of the window. Being so privileged to observe the rains from the (dry) sanctuary of my room, it proved nigh impossible to make it for morning lectures.

Much waters flowed into the lake and thence into the Mithi, and it was late 90's when I joined the alumni activities helmed by Sharad, Sudarshan, Parag, Mahavir, Ranju et al. After the alumni from the other 4 IITs were roped in and we saw large numbers attending the programs, there was a palpable pan-IIT alumni movement. Eminent worthies came to address the Mumbai Monthly Meets, including Julio Ribeiro, Bachi Karkaria, Medha Patkar, Rajendra Singh, and many others.

The monthly meets blossomed, and some life got infused into the gang. It so happened

Image credit: Image is sourced from https://unsplash.com/

that our Raja (Deshpande) was working at NABARD and offered to arrange a site visit for us to a village, Bhoyare Khurd, about 120 kms from Pune. They had assisted the villagers in transforming the drought-hit agriculture to growing bountiful crops in a paani lote programme – the desi way of saying ground water recharge. Around 40+ alums and spice (read many spouses) got into the Indrayani early morning to Pune on October 1, 2000 and there, piled into jeeps for a 4-hr rollicking ride. At Bhoyare Khurd, traditional wisdom was implemented for rain precipitation to percolate into the ground, thus raising the water table and ensuring ample water for their crops to flourish. Thaali peeth was had for lunch with the local yokels, us city-slickers absorbing the rustic scenario. This, you could say, was the alums' RWH 001, entry level for rain water harvesting and water conservation. Needless to also say that on the way back, the country's crème-de-la-crème could not arrive on the next step forward, for onward delivery to the community.

With this as backdrop, I made a game effort to curate a monsoon specific event next year, logically a music event and shastriya (Indian classical) at that. However, good friend Sudhir (Badami) pooh-poohed the idea – koi nahi aayega. History missed the date, Varsha Stuti-to-be was nixed and some mountaineering / hiking thingy took place in 2001. But with relentless persistence and bringing democracy into play, Sudhir was over-ruled for 2002. Thus Varsha Stuti was established for the end-August slot for venerating the rains. Since the medium was to be music, raag Malhaar and its various flavours became the default music to set the mood of the day. And I can confirm that very year there has been rain on the day, even if in the morning. Alumni propitiating the rains haven't faced a dry day.

With little money for the event, one had to convert connections and goodwill to take care of the fiscals. The first stuti fell into the alum-

ni lap, so to speak. That guy Raja again. His gracious and talented wife Ashwini (Bhide), now a sparkling light in the music firmament, agreed to come and even offered to waive charges for her performance. Tweaking the nascent IIT brand a bit with a liberal amount of angst provided the chill factor, literally. Fosters were our hosters for their brand of beer, supplying what Kreyzig would deem as necessary and sufficient quantity. So it was exhilarating music followed by a light dinner.

History missed the date, Varsha Stuti-to-be was nixed and some mountaineering / hiking thingy took place in 2001.

In between, one could proceed to the guest house to whet…err wet one's throat. A couple of rooms would serve as the adda, stocked with accompaniments in keeping with high standards for the intelligent elite (ahem…) on this august occasion. In short, the first Varsha Stuti set a very high benchmark indeed with the khana-peena and bajana. And with every passing year this built up steam (water vapour?).

Unfortunately, 6 years down the line, some H3 guys came to the g-h in an unconnected event and messed up the diro's dining room. This put an end to our transit bar since there was nothing official about it. More hurtful, all spirited g-t-g in the g-h were banned thereafter. But never has a Varsha Stuti gone dry, since blessings from the heavens always arrived.

Among the many luminaries who paid homage to the rain gods here was Smt Veena Saharabudhe, also an alum-spice and faculty then. She headed a music cell in the campus, rounding up the education for the nerds and other brains studying (or not) on the campus. And she also performed gratis. Nearer in time, we had a robust concert by one of our own, Pt Arun Dravid.

And may this tradition sustain. This is good exposure to the budding student, hopefully orienting her to the environment for the rest of her life. If IIT alumni wish to put back into the community, learning and implementing rocket science does not necessitate leaving terra firma at all; putting water in (literally) adds to the community good. Not too many alumni, even with millions in their bank, will have a +ve water balance. And this is the critical, nay, mission-critical factor for the country – shortage of water. Inter-linking of rivers can only destroy the riverine systems, harvesting rain will make them flow perennially. So our fore-fathers revered the monsoon. And sang paeans to the rains.

After all, if you want to make in India, it can't be water – this has to be harvested.

Janak Daftari
B. TECH. ELEC. E, '75

Janak is an evangelist for rain-water harvesting and waste management. He runs an awareness campaign called Jal Jagruti for students, professionals and citizens. He also provides technical inputs for implementing water conservation projects at site. A Bajaj and Stockholm awardee, Janak is actively involved with the Jal Biradari programs that aim to restore free-flow in all rivers, lakes, ponds, water bodies, etc. across the nation.

Winged Denizens of IIT-B

SIVARAMAKRISHNAN SIVASUBRAMANIAN

Black Naped Monarch: *Winter visitor, easily missed out due to its small size.*

Most birds in this series are either migrant visitors to the IIT-B campus or shy, relatively un-noticed residents. About five years back, both resident and migrant birds were found in larger numbers on our campus. Of late, due to excessive concrete constructions, especially on the lakeside, a large section of the migrants have given IIT-B the miss.

Blue Tailed Bee Eater: *Pre-winter visitor, active in late mornings*

Hoopoe: *A one-off-visitor; famous for having a cyclone named after it (hud-hud). Used to be a regular visitor to the campus and would frequent Gymkhana grounds during the period 1977 - 1995.*

Indian Pitta: *Summer visitor. Not seen in the last three years.*

Rufous Woodpecker: *Resident, active in early mornings. Once used to be a migrant with very infrequent sightings. (Above)*

Glossy Ibis: *Winter visitor. Seen in the picture in breeding plumage. (Right)*

Tailorbird : *Largely un-noticed resident. Named for its fame in making awesome nests. (Above)*

Yellow Eyed Babbler: *Winter visitor, has not been sighted in about three years. Once used to be very common, especially in Kol Dongri. (Below)*

Orange Headed Ground Thrush: *Extremely shy resident, used to be a migrant earlier*

Puff Throated Babbler: *Summer visitor, active throughout mornings.*

Shikra: *Winter visitor. Shy and ever vigilant.*

Yellow footed Green Pigeon: *Winter visitor, is the state-bird of Maharashtra. Used to be a rare sighting.*

White Breasted Waterhen : *Shy, resident, scampers on sight.*

Prof. Sivaramakrishnan Sivasubramanian

The author is a faculty member in the Department of Mathematics, IIT-B. He joined the institute in 2007 and has been seriously watching birds and mammals on campus since 2009.

Careers@Singapore:
Data Analytics

Contact Singapore had a chat with Manik Bhandari, Director of the Accenture Analytics Innovation Centre (AAIC), to find out how to unlock the hidden opportunities behind data analytics.

Organisations have always known that there is an enormous goldmine of information embedded in the data they have collected. The trick has always been in getting to it. Accenture believes that with modern data analytics and programming techniques, combined with astute business insights, we now hold the key to unlocking the secrets in these vaults.

However, a lingering challenge remains where the demonstrable benefits of data analytics fell short of the business managers' expectation. "This could be due to anything from not defining the right question to be answered, an inexperienced analyst and unclean datasets to incorrect application of insights to the business problem at hand," explained Manik Bhandari, Director of the Accenture Analytics Innovation Centre (AAIC) in Singapore.

This is where analytics centres, like the AAIC, come in. They are able to help bridge this gap by providing data analysis and consultancy as a service to help business managers discover the potential of data analytics, by helping them focus on the outcomes, and not worry about the analytics.

"We see ourselves as value architects who are able to help clients quantify results to demonstrate the power and application of data analytics in their organisations," Manik said. The AAIC team will guide the clients through the entire analytics project – educating, encouraging and reassuring them along the way.

> *"The range of data analytics application is extremely wide," commented Manik, "In a way, the potential of data analytics is limited only by the enthusiasm of the business manager and the resourcefulness of the analyst."*

To Accenture, Singapore represents a unique value proposition for data analytics. "The country is well-connected and organised. We are able to collaborate effectively with policymakers who have a clear interest to improve public services and citizen engagement. It presents us with an invaluable opportunity to create scalable models using real-time data which we can then replicate for application in other cities," said Manik.

In addition, there is a large and accessible scientific community for consultation and recruitment. The public sector is progressive and prepared to invest in cutting-edge innovation. The centre is also able to acquire clients who are keen to pilot and apply data analytics in their operations.

AAIC hopes that its efforts together with client organisations will eventually generate breakthrough solutions that will positively impact the lives of Singaporeans and global citizens. "It's just a matter of time," promised Manik.

Radio, Rodeo and Radia

BUNKUMBEE

There was a time when Communications travelled by air. By a route called radio waves. For news, cricket commentary or melodious songs, you fumed, fretted and fussed with knobs and dials on a contraption called a radio. The small fella was a pocket transistor and the big one was a radiogram. Between All India Radio and Radio Ceylon, operating at frequencies named MW and SW2, we could hear Dicky Ratnagar telling us the about the sounds of a seamer felling Tiger Pataudi's stumps. Or a mellifluous Ameen Sayani telling us, his *"beheno aur bhaiyon"*, why we should all gyrate to *'Dum Maro Dum'* on his *Binaca Geet Mala*. Some of these radio contraptions had something called an Ariel that was pulled up and sent up aerially to reduce distortions that sounded like an "oooooooooo...." that you heard in the preceding lines of RD Burman's '*Mehbooba*' song in Sholay. Rains, sparrows and strikes at All India Radio impacted the quality of these outpourings at times. But then, we were all complacent Indians-resigned to our lot and not the discerning or the demanding devils that we've evolved into. If you did not hear Indira Gandhi's shrill three-time rendition of '*Jai Hind*' on the ramparts of the Red Fort, big deal! You could catch it at your neighbour's house if he had a Zenith radio compared to your Blaupunkt, or you could see it in a Films Division documentary played out before the main movie, like *Kati Patang,* started. Or you could read about it in the postcard/inland letter that Shanta Mausi sent to you to tell you that she was well and hoped that you're well too.

Life was simple and uncomplicated. You had no expectations and a soul that was easy to satiate. Cricket, music and news was all there was in life

Life was simple and uncomplicated. You had no expectations and a soul that was easy to satiate. Cricket, music and news was all there was in life. When your fan stopped whirling and started creaking to a grinding halt during a power cut, you immediately pulled out a newspaper to start fanning yourself. That was a strategic back-up plan in an era of low expectations. Back then, battling 44 degrees Celcius, power cuts and resorting to newspaper fans to cool yourself, you raised your BP levels much less than you do now when the AC conks out, generator does not switch on in a minute and the temperature climbs from a 25 something to a 26 something. Of course, we all had heard of something called television that our "foreigner" cousins often boasted about. This was before we started berating and belittling them by calling them NRIs. In a television, as we were told, you could engage your eyes as well as your

Image credit: Image is sourced from https://unsplash.com/

ears. You did not need to crane your neck and stick your ear to the Murphy to figure out that Meena Kumari met someone while she was *chalte-chalte-ing* to Kamal Amrohi's faulty direction. You could actually see her in full glory, albeit a black and white one, and start agitating to get India into visuals in addition to the audios.

Delhi in the 60s, Mumbai in the early 70s, other metros in the late 70s, and rest of India in the early 80s moved to the visual medium that showed that the silly point we all heard about in cricket stadia was not so silly actually. Not at least in the black and white renditions manufactured at ECIL. The covers and the slips that we had heard about were not lingerie items, but something that Eknath Solkar and Gary Sobers dived into. Watching *'Dhoondo dhoondo re saajna'* was definitely more erotic than listening to *'Raat akeli hai....'* Madam Gandhi would sound more convincing if she talked about India's heritage before she hid her vintage pimples with rouge and rogues. Well groomed , convent educated Dolly Thakore, Luku Sanyal and Gitanjali Aiyer read out in faultless diction that Skylab was about to fall on a hapless population . (There's a story about alumnus Soumitra Banerjee who met Luku Sanyal in a *Durga Puja* pandal, did not recognize her, walked up to her and told her that she was familiar and she replied that she was a newsreader. Soumitra asked her why her lipstick looked red now and was grey on TV...but that's a different story about colour technology.)

There was a socialism that was attempting to manifest itself. Lohia or Fabian, there was a revolt against the special privileges enjoyed by our American cousins. They have TV. We too can have TV. They have twelve channels, we have one and that too part time. They have colour, we have black and white; but social-

ism levels, and we were about to level. Asiad 1982 was a great opportunity to showcase our corruption and inefficiency in full colour glory. Our athletes ran and stumbled in colour before an amused audience. We now realized that Sunil Gavaskar's bat was English willow wood and not made from white canvas. Lalitaji , the model for Surf actually wore soiled yellow sarees that were rendered white with detergent. This was a magic moment for India-one of upheavals and awakening. Sadly, Ameen Sayani had to bow out to *Chayageet*. Nobody really competed it. We just know that a clothing store called 'Babubhai Jagjivandas' sponsored it. But in colour, it was still a Government controlled Doordarshan that sold us scripts they wanted us to hear.

Now, as the world advanced from picture tubes to plasmas to LCDs, from 4:3 ratios to 16:9 wide angles, the content has moved faster than the technology that caused the content in the first place. You can marvel at Amitabh's henna hair in the backdrop of his *"Deviyon aur sajano"* line, watch kangaroos and giraffes in vivid colour and see everything and everyone faster than your fingers can work the remote, provided you can grab it from your spouse's hands. A problem of plenty? It's a good problem to have! But what happened to good old fashioned news reporting? That depends on whether you're talking in Hindi or English. In Hindi, you moved into *"sansannis"* where you see the minute by minute account of a "Prince" who fell into a hole and was rescued by an emergency relief operation in Patna before the Collector, who was rewarded by the CM. In English, you can watch a boxing match in the name of news. There are spokespersons who battle, gripe and insult!

Just try this for fun. Call up Arnab Goswami during News hour and pretend that you are from the ICICI sales team and that you want to give him a home loan. Start your stopwatch. He will answer and, before you even say "Hello", he'll start with "No! No! No! Just hear me. Just listen to me. The nation wants to know. Let me ask you....wait, wait, listen! Manish Tiwary! Please listen. Let me ask you Pawan Verma, Sambit Patra says that....wait, will you not listen? So, tell me Maroof, why should I take a home loan from ICICI? Nation wants to know!" 20 minutes later, after Arnab pauses for a micro-milli second, and Manish, Pawan, Sambit and Maroof all start speaking simultaneously, and before you dare to try to speak again, you'll be steamrolled by cacophony version 2015.

Everything in this world is good, bad and ugly like Clint Eastwood and his movies. But watching the present day news reporting does take you back into the good old radio world and make you wonder like a Sayani sponsored Mukesh.... "*Jaane kahan, gaye woh din....*"

Hic! Hic! Hurray! To radios and *mirchis*.

Bankim Biswas

Bankim Biswas has verbal diarrhoea dishing out his opinions on almost anything and everything under the sun. Most of it is a lot of bunkum and wishwash or should it be bunkum and dishwash?

Aposteriori

ANIL GANDHI

Image courtesy: Hindustan Times

The sun was about to set as waves lapped gently on the private shores of the Presidential estate in Hawaii. Tiki torches glowed in the fading light of dusk, as Pandit Obama played host to Acharya Modi in the verandah, classically decorated with artefacts dating back to King Kamehameha. Modi, dressed in Armani, did not mind being pampered in the least. It was a quiet evening between the leaders of the world's two largest democracies, as they discussed alliances and partnerships and Putin's shirtless poses.

Modi, got down to business soon after a round of cocktails, "Panditji, your country is very obese, it is driving your healthcare costs up. So why don't you send Americans to India and they can move their butts to Bollywood tunes. They can Shake in India."

Panditji, not entirely impressed, said "Ya, but it is too hot over there, isn't, it?".

"Well, yeah, it is kind of hot. It is funny you bring this up, Panditji, because it ties in with another initiative of ours, called Bake in India. It's so freakin hot you don't even need an oven, the whole damn country is an oven." As the evening progressed, the Shake and Bake in India conversation was batted around a bit, Panditji offered, "OK my friend, we can have Americans Shake and Bake in India, if you sign the TPP."

As word has leaked out, the two leaders have tied the knot on this rather secretive agreement, the TPP (Toilet Paper Partnership). Panditji, when asked by a reporter as he exited the retreat, simply said, "TPP is a great deal for the Americans and the Indians, it keeps American logging jobs at home so we can chop down old growth redwoods, but most of all Americans can make sure that India's ass is clean, since we are going to Shake and Bake there."

Dr. Anil Gandhi
B.TECH. ELEC. E, '84

Dr. Anil Gandhi is a data scientist and an entrepreneur. His current interests include using data to predict the future of using data to predict the future. In his spare time he data mines to improve performance metrics in semiconductor and other manufacturing.
You can admire his work by e-mailing to him at mindrate@gmail.com.

Whither Water Management ?

This section of our magazine includes a selection of 7 water-themed scholarly articles contributed by distinguished alumni, many of whom are also well known activists. The articles bring into focus the different dimensions of the water problem giving us plenty of food for thought.

While Shripad asks if we can solely depend upon technologies to manage water resources, Raghu argues that water cannot be considered alone when it comes to its management as a valuable resource.In their own way, both Upal Ghosh and Sharachchandra discuss the importance of mobilising social and political will to preserve the "quintessential environmental public good" that is water. While Himanshu Thakkar debates the viability of hydro-power projects, Jagdish's article highlights the ecological ramification of harnessing water by building dams and reservoirs over the last remaining free-flowing rivers. And, we have Nikhil's piece that delves deep into the water delivery chain.

Noseybee

Need for a Paradigm Shift

SHRIPAD DHARMADHIKARY

For many years, I was a full-time activist of a mass movement that is opposing one of India's largest dam, irrigation and hydropower projects. Some time in this period, a batch mate from IIT asked me, "Don't you think India needs such modern technology as dams, satellites, etc.?" I found this question very interesting as it termed 'dams' as a 'modern' technology, bracketing it with others like (artificial) satellites. I had two issues with such labelling.

First of all, dams as a technology are hardly 'modern' in the chronological sense. Humankind has been constructing dams since millennia. True, the size, scope and storage capacities of dams have increased by orders of magnitude over the centuries. Moreover, technologies involved in building these dams – materials, design methods, construction techniques – have all become much better, more sophisticated, and more complex. But at its core, dams as a technology have around for long. So I wondered whether we could really call them modern.

Another meaning of calling something modern is to indicate that it represents progressive intervention – progressive in the sense of enlightened thinking. Such a 'modernity' of dams is certainly questionable, for dams, in the very process of addressing our water needs – particularly as they grew in size and scope – have had huge adverse impact on people, and on the environment. Indeed, the entire range of technologies to control and manage water resources – dams, diversions, canals, pumping, hydropower – has led to displacement of people, drying up of rivers, salinisation of land and water, deforestation, destruction of bio-diversity and several other impacts. The levels of impact are such that they have often tended to outweigh the benefits they have brought.

Given this, a very important question is whether we can then depend upon these technologies to help us meet our water needs in the future, whether they can address the multitude of issues and problems we face in the coming days to manage water resources?

The answer, to me, is certainly "yes", but it is subject to a very different understanding of technology. I would argue that technology as a system – as a collection of scientific understanding and of various techniques – is quite different compared to its individual components. The same techniques and scientific understanding may be deployed differently to obtain strikingly different results. This 'deployment' of technology is crucial to whether technological interventions are progressive or not. Consider for example the case of the automobile. The way that automobile technology has been deployed in USA has created a system that is vastly different to the one that can be seen in say Europe. The system in USA has not only created a unique mode of transportation that is centred around the personal/

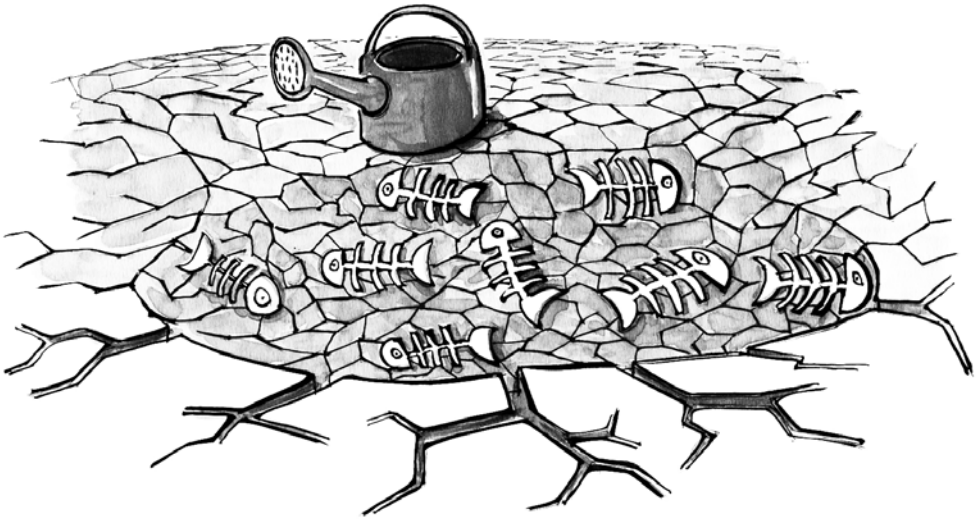


Image Source: Frits Ahlefeldt- www.landscapesofunderstanding.com/photo/1254/Drought-and-dead-fish-Color-illustration.html

private automobile, but in fact, it has influenced and moulded popular culture, thinking and everyday life in myriad ways. The same automobile technology deployed in Europe has produced a very different system.

Certainly, while some of the differences in deployment are related to specific local factors like area of the country, population density, etc., equally important have been societal choices. These are choices in terms of how and where to use the technology, for what purposes and so on. The sum total of these societal choices coalesces into a vision, and it is this vision that shapes how technology is implemented and what systems it creates. The water sector – in India and elsewhere – is no exception. The state that the sector is in today – and particularly the devastation that characterises most water resources – owes much to the vision that has driven water resources development in the country.

The central theme of this vision – if it can indeed be dignified as such –has been that "any drop of water that goes to the sea is a waste" and the effort has been to extract every last bit of water from rivers and other water bodies. Moreover, not only is this a highly anthropocentric vision, but even within human society has favoured the elite and powerful sections. Inequity has been part and parcel of the process, as has been a lack of concern for impact on the ecology and environment. The latter not only disregards the impact on non-humans, but also ignores the impact of ecological destruction on human communities. Tribals, rural populations and dalits have been the major sufferers. At the same time, rivers have dried up, or have been converted into sewage drains, or carriers of toxic effluents.

One is reminded of the song from the 1968 film Suhaag Raat, written by Indeevar, that goes गंगा मैय्या में जब तक ये पानी रहे, मेरे सजना तेरी जिंदगानी रहे (Let my beloved live for as long as there is water in mother Ganga). The singer is fondly wishing that her beloved lives forever, for it is believed that the Ganga will flow forever. Technology, deployed in the form of dams in the upper reaches of Ganga, has already rendered this belief naïve and false. And given that some of the tributaries, which areas much the Ganga as the main Ganga itself, have already stopped flowing below such dams, it would appear that the poor singer's beloved must have departed much much

sooner than she had ever thought possible. Many other rivers face the same fate. The Krishna, for example, has been declared a closed basin, that is, in many years its waters do not reach the sea.

What is happening to our rivers is only one part of the problem. Much is talked about these problems so I don't want to dwell on them. Suffice here to point out that these problems, apart from directly impacting the lives and livelihoods of millions of people, are also threatening the very sustainability of the existing water supply and irrigation systems, and are barriers to meeting the water needs of the future.

We need a very different, new vision of water resources management, a paradigm shift

We still will need many of these technologies to continue to meet the current and future water needs. However, we need a radical shift in the way these technologies are to be deployed, if we are to address current problems and avoid them in the future. We need a very different, new vision of water resources management, a paradigm shift.

It is interesting that many of the elements of this paradigm shift are being acknowledged even in the official circles. One of the important elements of this vision is to keep rivers flowing. In today's terms, this is being articulated as maintaining environmental flows, or e-flows. E-flows are not just 'minimum' flows, but are flows that mimic the variability of the natural flows in a river, and "sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems", which is the universally accepted definition of e-flows as enshrined in the Brisbane Declaration of 2007. A recent paper by the Ministry of Water Resources, Government of India, also accepts this understanding of e-flows. The Water Policy of Government of India, adopted in 2012, also mandates that all rivers will carry environmental flows.

The Government of India also has an ambitious program for Ganga Rejuvenation. It has declared that the "the long-term vision" for rejuvenating the Ganga "will emanate from the Ganga River Basin Management Plan being prepared by the Consortium of 7 IITs". The basic principles of this Management Plan extend further the notions of e-flows. They require that river management be based on restoring the "wholesomeness" of the river, which in turn is defined by four elements, namely "aviraldhara [continuous and connected flow] and nirmaldhara[unpolluted flow] as also its ecological and geologicalintegrity." They also bring in the notion of ensuring the connectedness of the river in three directions – lateral, longitudinal and vertical.

One would expect that these notions would also be eventually extended to all other river basins in the country. Of course, while some of these concepts are being articulated, the Government, with its affliction of multiple personality disorder, is also pushing ahead strongly with projects like Interlinking of Rivers, which are the very antithesis of the principles articulated above. So whether there is a genuine, even if slow, change in thinking is difficult to say.

But the need is to go even beyond that. Keeping rivers flowing is only one part of the change in paradigm that is necessary. We need to bring in a more holistic and comprehensive vision for the water sector, instead of bits and pieces. Water has to be seen primarily as "a sustainer of life and ecology", with the need to protect and conserve water resources, and reverse the adverse impacts that are already there. Water has to be seen as a social good before an economic good. There is a need to ensure equitable distribution of water, with allocation being done as per priorities defined

Image Source: Frits Ahlefeldt- http://landscapesofunderstanding.com/photo/1255/Dried-up-river-Color-illustration.html

by the Water Policy 2012. The policy lays down that "Safe Water for drinking and sanitation should be considered as pre-emptive needs, followed by high priority allocation for other basic domestic needs (including needs of animals), achieving food security, supporting sustenance agriculture and minimum eco-system needs." Water for non-human use should also be maintained. These are some of the key elements of such a holistic vision for water. In short, this vision tries to define an approach to water whereby natural cycles and pathways shall be maintained as much as possible, an approach where equity will be a central feature, and where judicious withdrawals and consumption will be the aim.

Again, such a vision is present in many ways in the several drafts that the Government of India has prepared of a "National Framework Law for Water". At the same time, many of the actions of the Governments (state and national) are very much against these principles.

While taking cognisance of these realities, one needs to appreciate the steps that are being taken in the right direction. Ultimately, in order to be able to address the current and future challenges in the water sector in a sustainable and equitable manner, we have no option but to pursue the building of such a holistic vision, and to use this vision to define our plans and interventions in the sector.

Shripad Dharmadhikary
B.TECH, MECH E, '85

Shripad Dharmadhikaray, B.Tech.,MechEngg, 1985 is an activist academic who practised applications of technology in the real world as an activist fighting against a big dam in India as part of NBA (Narmada Bachao Andolan). He is now trying to understand what is right and what is wrong with water and energy in India. He is the Founder of Manthan Adhyan Kendra, a policy studies centre engaged in research, monitoring and analysis of water and energy issues.

Water, Environment and Technocracy

HIMANSHU THAKKAR

Technocrats have been the most significant players in the world of water resources development and management. They are the ones who plan, conceive, design, build, operate and manage our water resources from dams, hydro-power projects, urban and industrial water supply systems, including the sewage and effluent treatment plants.

So in this world there are neat categories like users of water and suppliers of water, and solutions, similar to any other resource use say energy, telecom, roads or goods. There are issues of resource scarcity, efficiency, quality, allocation of scarce resource, and regulation and there are business models to deal with them. One key difference, however, unlike in case of other resources mentioned above, is that storage, use, development, management, and disposal of used water has impacts on the environment. Our water technocrat would say yes, of course we know this. So there are environment impact assessments and environment management plans.

However, water is a bit strange. Water is in fact embedded in the environment. So whatever you do with water has an impact on the environment. Secondly, water is so essential for all life that if we want to see any sign of life, we look for signs of water. So water in nature is essential for every living being. Water in nature also is a resource on which livelihoods of a vast number of people, particularly the poor, depends. Water in nature also occurs in complex ways.

Take rivers for example. We engineers are taught to define a resource so we were looking for a definition of river. We soon realised, no comprehensive definition exists, the government has not even attempted one, as Union Water Resources Minister accepted publicly. At India Rivers Week, that some organisations including South Asia Network on Dams, Rivers and People (SANDRP) organised in November 2014, a detailed definition of rivers was arrived at:

"A river is more than a channel carrying water; it is also a transporter of sediment; it is also the catchment, the river-bed, the banks, the vegetation on both sides, and the flood-plain. The totality of these constitutes a river. A river harbours and interacts with innumerable organisms (plant, animal, and microbes). It is a natural, living, organic whole, a hydrological and ecological system, and part of a larger ecological system. A river is also a network of tributaries and distributaries spread over its basin and the estuary. As rivers flow, they perform many functions. Rivers are the major geomorphic agents which sculpt the earth's surface by incising deep valleys, carrying rocks and boulders and turning them to gravel, sand and clay. They support aquatic and riparian bio-diversity (flora and fauna); provide drinking water to human beings, their livestock and wildlife; influence the micro-cli-

mate; recharge groundwater; dilute pollutants and purify themselves; sustain a wide range of livelihoods; transport silt and enrich the soil; carry essential sediment to the estuary and to the sea; close the hydrological cycle by flowing to the sea, and maintain the temperature and salinity gradient in the sea, which are among the key drivers of the monsoon; prevent the incursion of salinity inland from the sea; provide nutrients to marine life; and so on. Rivers are also integral parts of human settlements, their lives, landscape, society, culture, history and religion."

Wish our civil engineers take note of this definition! The definition sounds complicated, but a river is a complicated ecosystem.

Indians are known to revere rivers, more than possibly any other nation or society. But what is the value of a river in the scheme of our government? The answer could be found if you pick up any policy or plan document or an EIA or cost benefit analysis of any dam, hydro-power project, irrigation project or diversion or embankment project. You won't find any value for a river in any of these documents. A dam or hydro-power project destroys a river as it exists. It certainly generates benefits, but should the river be mentioned among the costs?

Let us see how our official agencies deal with rivers and water resources. Take Central Water Commission, India's premier technical body on water resources. It is the generator and storehouse of all kinds of water resources data and studies. It is also in charge of policy making, development, management, flood forecasting, dam sanctioning, dam safety, techno-economic clearances, monitoring, disputes resolution, environmental reviews, rehabilitation review, river basin planning, and so on. For any official expertise in water resources, even judiciary has no one to turn to, except CWC. However, the first issue that strikes you about CWC is that there is a conflict of interest among the various functions of the CWC. In USA, for example, United States Geological Survey is in charge of only generating credible hydrological data and putting it all out in public domain promptly. USGS does no development work, so its data tends to be reliable. You ask anyone familiar with hydrological data in India, the first thing you would be told is that most of it a state secret and secondly, the quality of the data is rarely reliable. But there is very little questioning of the functioning of CWC. CWC has not set a definition or value for rivers except seeing them as sites for dam building.

However, water is a bit strange. Water is in fact embedded in the environment. So whatever you do with water has an impact on the environment.

If you watch CWC closely, you will notice that it is more like a big dam lobby that does not like any independent participation, transparency or accountability. In fact, CWC generally refuses to accept that any expertise exists outside CWC!

CWC also does not like the word environment. The trouble is, this word environment is a bit of an irritant for most of the water technocrats. They have traditionally disliked it. They also dislike phrases like conflict of interest. The dam engineers also seem afraid of a word called decommissioning. They have striven to keep that word out of the official jargon so far. That is one of the reasons why CWC does not want to allow decommissioning of the 120-year old Mullaperiyar dam in Kerala.

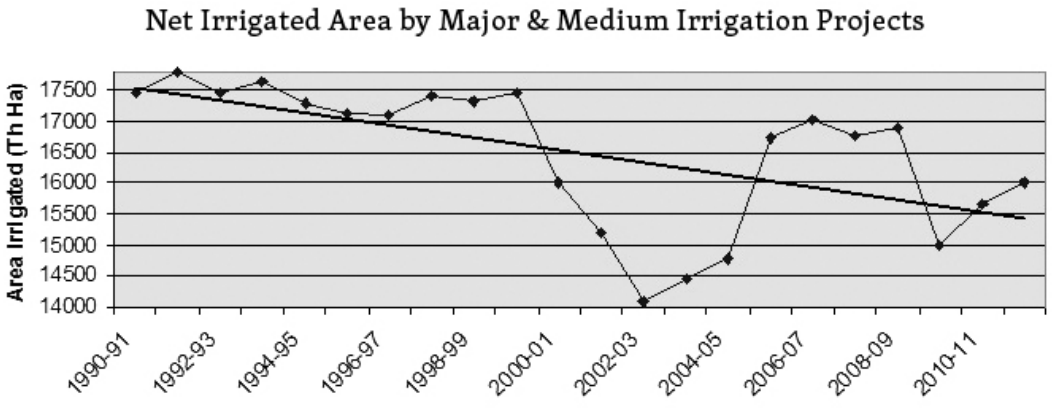
But there is also some positive things to report even in Dam world! The report of the World Commission on Dams, released in November 2000 by Nelson Mandela in presence of the then World Bank President in London

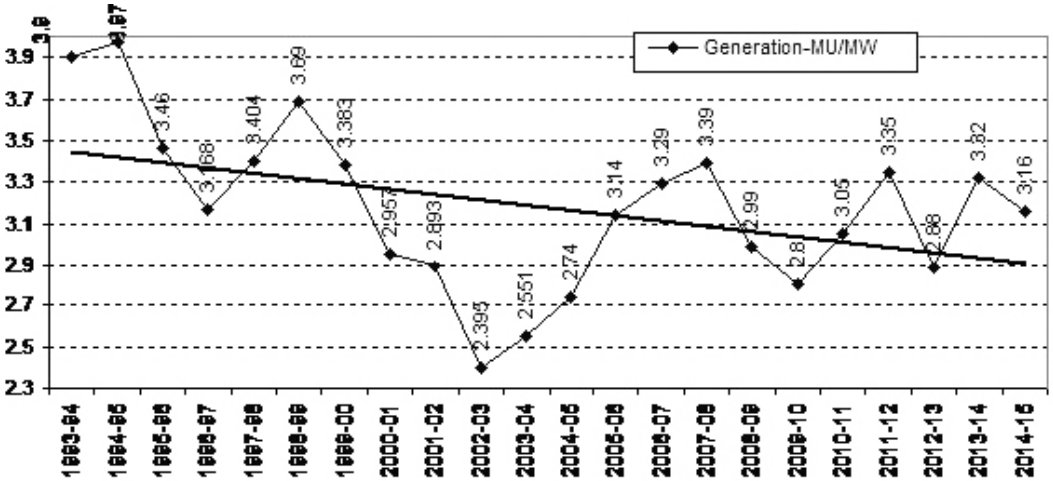
is one for example. It is not possible to go into all the details of WCD here, but in brief, majority of the 12 members of WCD were dam supporters all their life. The commission was funded by World Bank, UN, and a number of governments around the world. Most stakeholders including governments (India, China, among others) participated in the work of WCD. The report did not criticise all dams nor did it recommend that no dams should be build. In fact the report started by saying that the dams have made significant contributions. However, it also stated that huge, and many times unnecessary, costs have been paid for the dams and the benefits accrued were not as promised. It recommended a framework for future decision making. We believe this provides a way forward and any project that follows the WCD recommendations will have wide public acceptance. But unfortunately, we have yet to see their Implementation.

Another positive news was even more recent and involved an alumnus of IITB. Jairam Ramesh was arguably India's best ever environment minister. He did a lot of interesting work as environment minister. One of them was the commissioning of the Ganga River Basin Management Plan. Unfortunately, he was so enamored by his alma mater that he gave that task to a consortium of IITs! It was a bit of problematic decision. For the issue of rivers or Ganga is not a purely technological issue. It is not even primarily technological issue, but essentially a governance issue, where I believe, IITs have very little expertise. But that is another story.

Coming back to the dams that dominate our water resources development so completely, let me provide a couple of snapshots about these dams.

Out of over 5,100 large dams that India has built, over 95% are purely irrigation projects. These are called major and medium irrigation projects in government parlance. In the graph below, I have plotted area irrigated by these M&M irrigation projects over the last couple of decades. This is all based on government data, such water data are government monopoly in India. It shows that net area irrigated by such projects reached a peak of 17.7 million ha in 1991-92 and never reached that level again. In fact the trend line is going down with loss of about 1.5 million ha in two decades. In these two decades, India has spent over Rs 800,000 crores on M&M Projects.





Let us look at hydro-power projects. In the graph below I have plotted electricity generation (million units) per MW installed capacity from India's all generating hydro-power projects, over the last two decades. This is based on data from Central Electricity Authority, India's premier technical body on electricity issues. This graphs shows that generation per MW installed capacity has been falling and has reduced by over 20% in the last two decades. This means that every MW hydro-power project generated about 20% less power than it did in 1993-94.

This is not an advocacy against large dams. These two snapshots are provided to raise questions even about the performance of India's dams. I feel institutes like the IITs need to grapple with real life issues like these in real time, in an independent, fearless way. I hope that happens and soon!

Himanshu Thakkar
B. TECH. CHEM E, '84

Himanshu, an engineer from IITB, is currently coordinator of South Asia Network on Dams, Rivers and People and editor of the magazine Dams, Rivers & People. In the past he has been associated with the work of World Commission on Dams, Narmada Bachao Andolan, and Centre for Science and Environment. He writes at www.sandrp.wordpress.com/

Water: A Quintessential Public Good that Needs Public Solutions

SHARACHCHANDRA (CHANDU) LELE

Bring up the topic of water, and you are bound to get everybody's attention and probably a heated discussion going. Water is a part of our lives in so many different ways: not just for survival activities of drinking or cooking, but also in the production of our food, in many industrial activities, and even as a carrier of our waste. And in India, as in many other densely populated and rapidly industrialising sub-tropical regions, water scarcity, water pollution and too much water (flooding) are all major societal challenges. Responding to these challenges properly requires understanding how water is the quintessential environmental public good, and what kind of public actions may be required.

The physical side: flows, connectivity, and return flows

It is useful to start with some clarifications of the physical side of the story, i.e., the hydrological cycle. The terrestrial portion of the hydrological cycle and how it changes under human-dominated conditions is shown in Figure 1. The first point to note is that water is a 'flow' resource. It moves all the time—over land, through soil and through plant systems—and makes its way back to the atmosphere through evaporation or transpiration to come back (somewhere) in the form of rain/snow.

Second, the only 'consumptive' use of water is that which results in evaporation or transpiration. Indeed, the major human intervention in the hydrological cycle is through increased transpiration from irrigated agriculture, leading to a shortening of the cycle—the water evaporates before it reaches the oceans. Most of the other uses are non-consumptive but polluting—water is released back into streams, but in a more or less polluted form (see right side of Figure 1-B).

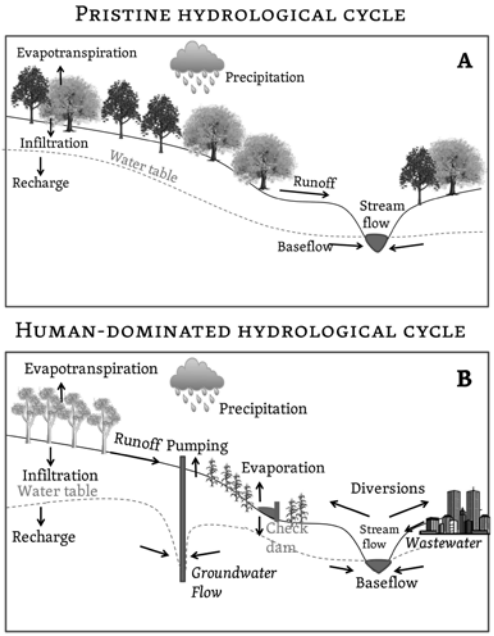


Figure 1. The hydrological cycle under pristine conditions (A) and human-dominated conditions (B)

Third, groundwater is nothing but rainwater that infiltrated and made it past the roots of vegetation (=recharge), and since what goes in must come out at some point, recharge

eventually shows up as baseflow contributions (=discharge) to streams and rivers, or even directly to oceans. This means that any extraction of groundwater reduces river flows or discharges to the ocean (see left side of Figure 1-B). Similarly, any effort to 'augment' groundwater by, for instance, building check dams only repartitions water flows from surface to ground. Rooftop rainwater harvesting captures water earlier, also reducing surface flows. In other words, it is not possible to create 'new water', except through desalination, which is an enormously energy-intensive technology.

Fourth, the remaining part of the hydrological cycle is also important. Rivers eventually empty into oceans, from which the water evaporates to form clouds, which, in the Indian case, bring rain to the subcontinent. It is inappropriate to think of that water as 'waste'—the estuaries at the mouths of rivers where sweet water mixes with salt water are enormously productive ecosystems with some of the richest fisheries.

These physical features of the hydrological cycle have major implications for how we think about and organise the use of water. They tell us that water is a quintessential 'public good' which cannot be privatised. One may think that a Bisleri bottle or a tanker is a privatised form of water, but that is only temporary. Eventually it flows through our toilets back to the ecosystem downstream, and the extraction of that Bisleriwater also affected someone else using water from the aquifer. In other words, water is a common-pool resource that links upstream to downstream. And all forms of storage and diversion, large or small, create not only downstream impacts but also impacts through submergence and land loss, ecosystem changes, and so on. Thus, water management requires 'public institutions' that regulate allocation at the scale of the resource to address the core allocation questions: Who should use how much water at whose expense? And who may release how much effluent where and at what quality? How should allocations be made between surface and groundwater users, if they are part of the same cycle? And the work of these public institutions must be underpinned by rigorous, multi-disciplinary and 'public' science, i.e., science that transparent to the public.

Indian situation: non-transparent science, 'care'-less engineering, weak institutions

Unfortunately, the situation in India as regards to this common pool resource is rather discouraging at the moment. Alarming rates of groundwater depletion are only matched by equally alarming levels of water pollution in rivers and declining flows in the rivers. While the social impacts of groundwater overuse will be felt in the future, the indirect impacts in terms of increasing electricity consumption and indebtedness of farmers who spend on drilling borewells that fail are already visible.

A new generation of scientists is also emerging that wants to tackle socially-relevant hydrological questions

Figure 2. The open wells have dried up in most parts of peninsular India, where borewell pumping has lowered the water table drastically (Photograph by: Kirubaharan Jeremiah)

Figure 3. Most rivers near cities have become sewers: the Vrishabhavathy river in Bangalore (Photograph by: Priyanka Jamwal)

While average water supply in many cities appears quite adequate on paper, high leakages and inequitable distribution create pockets of high scarcity, with the poor often paying the highest rates per litre. And the socio-environmental costs of large dams are visible everywhere.

The reasons for this situation are several, but a common thread is the non-recognition of the public good nature of the resource and of the need for public institutions and public science and socially sensitive engineering. On the science side, groundwater monitoring agencies set pumping limits without considering the impacts on surface flows. And their data are largely not in the public domain and not subjected to rigorous scientific analysis. The hard-rock aquifers of peninsular India present a particularly daunting challenge in this regard, but the scientific effort in this regard has been very limited. Similarly, flows in most rivers are either not monitored or the data are not accessible to the public, thereby preventing rigorous analysis for understanding the impacts of human intervention.

Decision-making in the water sector is dominated by engineers who think any water going to the sea is a waste, who are blind to the social costs of large dam projects, and who focus on building sewage treatment plants but not on the sewerage network required to bring sewage to the plant, nor do they address the operation and maintenance challenges faced by these plants or by irrigation canals.

Our regulatory institutions are weak (in the case of surface water) and non-existent (in the case of groundwater). Pollution control board officials are bogged down in paperwork and spend little time monitoring pollution in the field; corruption is a constant presence. In structuring these agencies, the issue of transparency and downward accountability to water users or potential pollutees has been given the go-by: the governing boards of all these agencies are stacked with bureaucrats who keep rotating and their CEOs are officers on short-term deputation from other departments. River water dispute tribunals struggle to meet the workload with very limited access to data or high-quality science.

Emerging movements and opportunities

Despite this daunting picture, citizens' movements are emerging across the country in various forms and shapes to make a difference. At the simplest do-it-yourself level, urban citizens are setting up networks to measure and publicly share city-wide rainfall patterns. Corporates are teaming up with NGOs to reduce their water footprint and improve water budgeting. But citizen groups are also putting pressure on municipal agencies to rejuvenate lakes and offering their time for monitoring

and maintenance. In a few villages such as Hivre Bazar in Maharashtra, the gram sabha has banned the digging of borewells and imposes restrictions on area irrigated during a drought year. In other regions, movements for river rejuvenation and maintenance of ecosystem flows have caught on. Groups are petitioning the National Green Tribunal to prevent further diversions of river waters or appropriation of waterfront lands. A new generation of scientists is also emerging that wants to tackle socially-relevant hydrological questions.

These movements also represent an opportunity for innovators: technological and social ones. For instance, there is enormous need for cheap instruments for automatic monitoring of deep groundwater. As also instruments for measuring stream and river flows, monitoring pumping rates from borewells, and sensing water quality at factory outlets and in-stream. Similarly, there is space to innovate different models of domestic sewage treatment and disposal, including linking farmers to the sellers of sludge, linking neighbourhood parks to sellers of treated water, and so on. Such opportunities will expand as the pressure grows for lasting, environmentally sound and socially fair solutions for our water problems. Water is too important a subject to be left to engineers and bureaucrats alone. It is a public good problem that will require broad-based public engagement and the building up of a groundswell of opinion that will enable some difficult choices and innovative solutions.

Sharachchandra Lele
B.TECH. ELEC E, '84

Sharachchandra Lele spent most of his IITB days doing trekking and wildlife-giri, and GSec-giri (Garden Secretary and General Secretary of H-5). Somewhere along the way he realised thathe did not want to really be an engineer, and so in spite of the Silver Medal in Electrical Engineering, he veered off into environmental studies, doing a Masters at the Indian Institute of Science on valuing the environmental impacts of big dams, and then a PhD at University of California, Berkeley on understanding forest use and its impacts in the Western Ghats. He is currently with the Ashoka Trust for Research in Ecology and the Environment (ATREE: www.atree.org), an applied environmental research institute. He works on forests, water and the climate change-development conundrum from a highly interdisciplinary perspective.

Water, Water, Everywhere, Nor Any Drop to Drink

RAGHU (GUDDU) MURTUGUDDE

India has an ocean named after itself and has a coastline of over 7500 km. So India is essentially surrounded by water. But agriculture, which contributes about 25% to the GDP and offers up 60% of the employment, is largely rain-fed and thus perpetually subject to the vagaries of the monsoon dance. Even the bread basket of India, viz., the rich farmlands of Punjab and Haryana, and the rice bowl of India in West Bengal are highly vulnerable to the multi-decadal decreasing trend in the monsoon because of the unsustainable exploitation of groundwater for irrigation. Clearly this is a reminder of The Rime of the Ancient Mariner – water, water, everywhere, nor any drop to drink. It is, however, key to remember that water cannot be considered alone when it comes to its management as a valuable resource. Water, food, energy, and health are inseparable resources.

Indian Monsoon – The Lifeline for the Country

Monsoon is an evocative concept derived from the Arabic word mausam, which means season. The summer monsoon over India, with its dramatic arrival and a season of unpredictable nakhra, has indeed served as a motivation for many a prose and poetry for millennia. It is the lifeline for the food, energy, and water security of India. A major driver for the onset of the monsoon is the northward thermal gradient between the fast warming of land during the northern spring and summer months compared to a slower warming of the Indian Ocean due to the difference in their heat capacities. The spectacular onset over the southwest corner around the beginning of June used to occur around June 01 prior to 1976 and has since been delayed to about June 05. After the onset, the monsoon advances northward to cover the entire country in a few weeks to establish the monsoon season and the crop calendar. The season comes to an end with a systematic southward withdrawal which is completed in early October. The withdrawal has advanced by few days since 1976. Thus the length of rainy season has been detectably compressed due to the delayed onset and the earlier withdrawal, leading to squeezing the rainfall into fewer days. Heavier rainfall events have been on the rise.

What is so magical about 1976? The normally cool sea surface temperatures in the equatorial Pacific around Galapagos warm up once in a few years and shift the rainfall center from the warm waters off New Guinea to central and eastern Pacific. This anomalous warming of sea surface temperatures and the associated shift of the convection from the west Pacific to the east was consider a gift from God by the Spanish colonizers and is referred to as El Niño – as in the boy child or the Christ Child, due to its arrival around Christmas time off the west coast of South America. El Niño affects the monsoon but since El Niño really peaks in the winter

Image is sourced from https://unsplash.com

months but the monsoon occurs 6 months before in the summer months, it is not always clear who leads when El Niño dances with the monsoon. The decades prior to 1976 were characterized by fewer and weaker El Niños whereas the decades since have had stronger and more frequent El Niños. The net impact appears to be a squeezed monsoon season.

Superimposed on the monsoon and El Niño which are natural modes of variability, global warming has been tinkering with the system also. The Indian Ocean is warming rapidly due to global warming but the Asian landmass has not been warming as rapidly as expected because the pollution or the particulate matter in the atmosphere, referred to as aerosols, have reflected sunlight to slow the warming. This has resulted in a decreasing trend of 10–20% over the Indo-Gangetic plane over the past century. Past ice ages had also led to a decrease in the strength of the monsoon due to changes in temperature of the North Atlantic Ocean. It is a cruel irony of nature if both ice ages and global warming end up weakening the monsoon. But this should serve as a wakeup call for slowing down the rampant groundwater mining and to develop local, regional, and national plans for sustainable water resource management into the future with a keen eye for the water–food–energy–health nexus since these are inextricably tied to each other.

It is also worth reminding ourselves that the water issues are not constrained by geographical boundaries since the rivers are shared by India with its neighbors. More importantly, the extreme vulnerability of our neighbors are necessarily our vulnerabilities also. For example, the low lying areas of Bangladesh are under increasing risk of storm surge and inundation due to increasing sea levels, extreme rain events and increasing cyclones. A large scale devastation and the associated human displacement will produce an environmental migration knocking at India's doors.

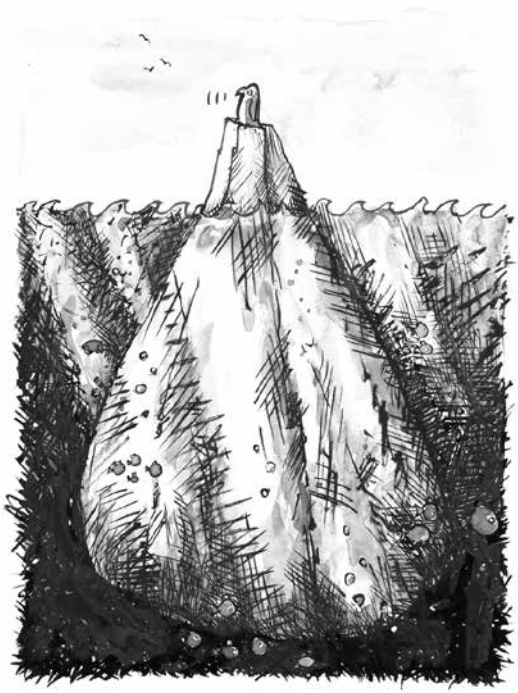


Image credit: Frits Ahlefeldt: http://hikingartist.com/2014/05/16/lone-penguin/

Grand Challenge –Safe navigation of the future of Water, Food, Energy and Health

Water is a quintessential environmental issue in terms of quantity, quality and access. While global cooperation is being attempted under the UN Framework Convention on Climate Change as a united response to global warming, the negotiations move at a glacial pace considering the complexity of the issues. Unlike the ozone hole problem where all humans stand to lose, global warming will create winners and losers. This makes it imperative that a country like India be a good citizen of the global community and play its role in combating local warming while being as self-reliant as possible in reducing its vulnerability to climate variability and change and enhance its resilience as far as possible to make itself a weather and climate-ready nation.

As the pent-up demand for continued economic growth determines most political agenda, there are many lessons to be learned from a country like China which grew to be a manufacturing center for the world at the cost of importing pollution that is now blamed for over 1million premature deaths each year. India is not far behind even before it has accomplished its goal of Make-In-India. Many millions remain without running water and electricity which puts an additional burden on water and energy demand, while the urban–rural–industrial–agricultural competition for water and energy creates unintended consequences as solutions are sought piecemeal. Leapfrogging the follies of the industrialized world and the imperfect growth model of China requires that India seek solutions that are local, sustainable, and as environmentally safe as possible while still continuing to improve the quality of life for its citizens.

Critical technology for a critical time – Innovations for Water, Food, Energy and Health

The Institute for Globally Transformative Technologies (IGTT) at the Lawrence Berkeley National Lab recently released a report citing the 50 most critical scientific and technological breakthroughs required for tangible sustained development. The IGTT report may serve as a starting point for prioritizing the list of required breakthroughs for solving specific problems in the water–food–energy–health nexus, the key challenges they present, and the promising interventions available. Bottom-up solutions in terms of the nuts–and–bolts required for true sustainable development, including policy reforms, behavioral change and necessary financial, infrastructure, and educational developments can be evolved with the brainpower that exists within the country. Swaccha Bharat has to be as much about sweeping away the garbage as the cultural mores that tell us to clean our living quarters but do not tell us that we shouldn't be dumping our garbage on the streets willy-nilly nor about all the air and water pollution we

are causing because of our ever increasing standards of living. Some specific potential solutions that can ensure quality of living in addition to the standards of living can serve as illustrations.

The enormous reservoir of water offered by the Indian Ocean can be exploited with low-cost, scalable desalinization methods, which would be a monumental breakthrough for much of the country. This can not only alleviate the water stress in terms of industrial and agricultural demand but can help avoid the virtual hydrologic cycle that moves water from water-scarce regions to water-rich regions via the bottling plant operations for soft drinks. But the vast interior of the country will have to seek other affordable and viable solutions such as agroforestry – a combined forestry–agriculture–horticulture approach – that has been shown to be a robust and sustainable watershed management and food production method. Intelligent design of sea-based transportations can also connect the coastal regions to reduce congestion and pollution of the land-based transportation.

For human and animal health issues, in addition to effective vaccines, testing kits, medical instruments, innovation and implementation of inexpensive, large-scale air and water quality monitoring are needed with hand-held sensors for rapid testing of contamination levels. Digital libraries of all common pathogens can be set up and linked for verifying potability of water.

In addition to the large-scale energy production as a combination of hydro, nuclear, solar, wind and wave energy, small scale off-the-grid designs will help run refrigerators to store vaccines, medical samples, and nutritious food for infants. Weaning the country off the carbon-intensive energy is as important as reducing water demand for energy production.

Energy demand must also be reduced for agriculture by innovation of safe fertilizers and pesticides that can be produced with minimal energy. Water and energy demands can both be reduced by low-cost, smart systems for irrigation. Agroforestry can be made more effective with organic herbicides and repellents for weed and pest control and drought-resistant seeds. Agro-innovation must also focus on off-the-grid refrigeration for cost-effective animal breeding operations in a warming climate and also high-nutrient/low-cost animal fodder, and portable toolkits for extension workers who serve regions not reached regularly by veterinarians and for the veterinarians themselves.

It is also worth reminding ourselves that the water issues are not constrained by geographical boundaries since the rivers are shared by India with its neighbors.

The IGTT report recommends a utility-in-a-box approach for deploying cost-effective renewable energy mini-grids. India will benefit enormously by designing affordable housing that is resilient to extreme weather, fitted with renewable energy sources and environmentally friendly plumbing with easy transportability to rural and remote areas.

Information Revolution – Are we there yet?

India has capitalized on its long-term investment in science and technology education by serving as an IT outsourcing hub. But it is arguable whether the country is on target for the behavioral changes and development of human capital for an equitable growth that is environmentally safe. The increases in investments for Science–Technology–Engineering–Mathematics (STEM) education has focused on establishing more and more IITs and IISERs. Climate change and global warming are ultimately social science problems and the country will do well to develop equally strong educational infrastructure for social

sciences. STEM education will be a success when it can combine the science, technology and engineering prowess for societal good; for example, by implementing evolving futuristic concepts such as the Internet of Things: digital devices coupled together to create an integrated system whose sum impact is far greater than that of its components. While smart-cities is a buzzword in India now, a digitally connected system would exploit common devices such as smartphones and laptops to ensure interoperability among devices, provide continual feedback to users, and apps that would link the components of a system with common protocols, and allow users to share data for developing transferable solutions and rapid transfer of experiential knowledge from one community to another. Internet of Things should also allow universal access to digital learning tools, books and online courses, with the devices simultaneously serving as environmental sensors for temperature, humidity and wind-speeds, soil moisture and maybe even pathogens.

Leapfrogging the follies of the industrialized world and the imperfect growth model of China requires that India seek solutions that are local, sustainable, and as environmentally safe as possible while still continuing to improve the quality of life for its citizens.

Prognostic Tools for Navigating the Future of Water–Food–Energy-Health Nexus

Another innovative step India has taken is to build on its science and technology education by advancing the understanding and forecasting of the monsoon. An investment of over ₹400 crores was made under the aegis of the Ministry of Earth Science in establishing a dynamic monsoon forecast system along with the required supercomputing facility at the Indian Institute of Tropical Meteorology in Pune. In a unique and bold approach, scientific expertise from around the world has been invited to help advance the process and predictive understanding of the monsoon.

Since the monsoon occurs in fits and spells called active and break cycles, the dynamical forecasting efforts are focused on both, sub-seasonal and seasonal timescales. While the forecast of seasonal amount of rain in terms of whether it will be normal or deficit or excess is critical for the total food production and water resource management, the sub seasonal or active/break timescale forecasts are indispensable for agricultural operations, especially for rain-fed agriculture where irrigation is not an option.

This modeling effort also includes the Center for Climate Change Research within IITM-Pune, which is focusing on long-term projections of climate change and monsoon response to global warming. These projections will also assist in a holistic planning for managing the future of the water–food–energy nexus and also other related vulnerabilities; for ex., vulnerability to sea level rise, human and animal health, potential climate-driven conflicts, etc.

Much needs to be accomplished in terms of synergizing the research community, workforce training, and the public-private sector participation in not only advancing the understanding, predictions and projections of monsoons but also delivering this information in usable and actionable form to individuals, groups, and policy and decision-makers. It is commendable that the country has invested in the infrastructure needed to realize these important goals.

Image Courtesy: Hindustan Times

Bringing it all together for a Secure Future in Water, Food and Energy

It is clear that water cannot be thought of independently as a resource now without considering its intimate co-variability with food, energy, and health. And this nexus cannot be navigated safely into the future without combining education, information, innovation, policies, and governance. We are indeed living through interesting times since climate change is affecting this nexus in unpredictable ways. The least vulnerable system can only be about managing the unavoidable and avoiding the unmanageable when it comes to water for life.

Raghu Murtugudde
B. TECH. AERO E, '83

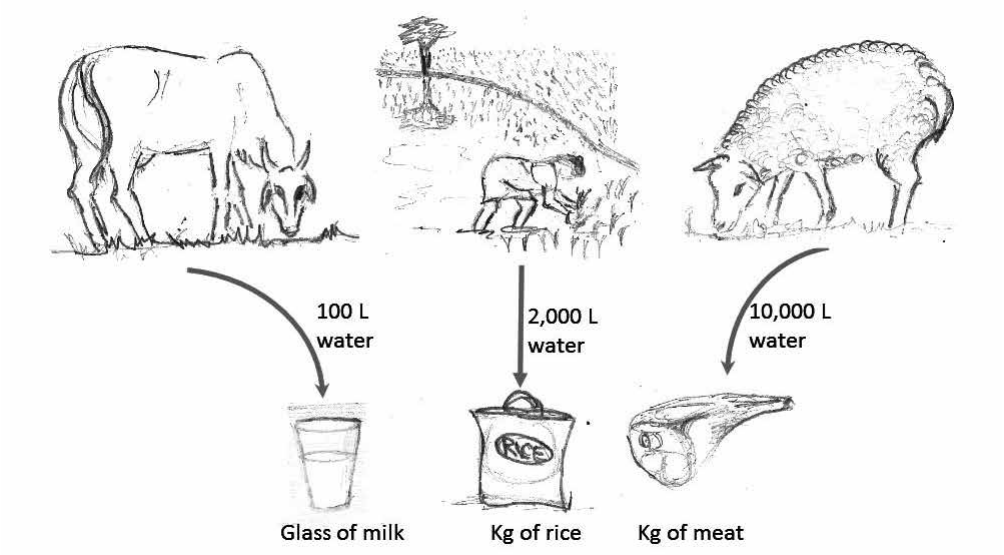
Raghu Murtugudde is an '83 Aero alum following which he continued to sell firewood with his father in Dharwad for 6 months and returned to Aero as a project scientist. He went to the US for an MS in Aero from UT-Arlington, and a Ph.D. in ME at Columbia Univ. During his stint at NASA and as a faculty at UMD he took his CFD expertise to climate modeling including climate impacts. He has been engaged with NGOs on sustainable agriculture methods and research on human mind and its limitations in accepting risks that are not obvious and imminent like climate change.

Water: Thirsty for a Change

UPAL GHOSH

We were perhaps the last batch that saw a functioning boat club in the IIT campus. I remember taking out a row boat from the now defunct boat house on Powai Lake and going around 'Croc Island' where the reptilians were known to nest. We lost that privilege by the end of my first year as the boat dock became overwhelmed with water hyacinth that was rapidly spreading in the lake stimulated by the high levels of nutrients coming in with untreated wastewater. Such loss of privilege to services from a water body plays out at a national scale as we slowly resign to the decaying quality, unsightly trash, stench, loss of natural habitat and function. Of course in IIT we would not give in easily without a fight. So a bunch of us teamed up and with the help of the then director of CESE, Dr. Khanna, started a research project on the eradication of the water hyacinth! We brought in an expert and embarked on a biological control experiment by introducing a hyacinth-eating weevil (a type of beetle). While the weevil finally lost to nutrient-driven explosion of the water plants, the engagement made a lasting impact in our lives and several of us in that group went on to work in the field of water.

Most of us take water for granted. But for nearly a billion people in the world, access to safe drinking water is a daily challenge. The excess of water we see around us – flowing tap water in most urban homes and images from the recent monsoons and floods–seem to desensitise us from the need to care for water. There appears to be plenty going around. The problem is that even with this plenty, there are a lot of takers. Water for drinking and washing is not all we need. Nearly every action of ours is linked directly or indirectly with a large industrial consumption of water. For example, a glass of milk can be equivalent to 200 L of water, a kilo of rice equivalent to 2000L of water, a kilo of lamb 10,000L! So, while we drink about 2L of water per day, our implicit use of water is about 2500L/day for an average Indian, and a whopping 7000L/day for an average American! What does 2500L/day for each person mean for the whole of India? That is close to the entire flow rate of the Ganga and the Brahmaputra combined! Scholars have giv-



en various names to the implicit use of water: 'virtual water' or 'water footprint'. Starting from our ancient civilisations, we have recognised humankind's tremendous dependence on water, continue to be challenged by it, and often fight over it.

The use of water is a double-edged sword – there are impacts from the diversion of the large volumes we need for consumption and even greater impacts when we release back the large volumes of wastewater into the rivers. Successful civilisations have found ways to manage their waters efficiently. From the amazing sanitation systems of the Indus Civilisation, to the magnificent aqueducts of the Roman Empire, and the large-scale treatment plants of today, when the political leadership has given it priority, engineers have innovated ways to make it possible.

Our late Prime Minister Indira Gandhi put it eloquently: "Poverty is the worst polluter". But, now that we have started to address the challenge of poverty and India is an emerging economy, have we been able to do enough to keep our waters clean? It is heartening to hear from our current leadership about prioritising the clean-up and revitalisation of our major

A glass of milk can be equivalent to 200 L of water, a kilo of rice equivalent to 2000 L of water, a kilo of lamb 10,000 L! So, while we drink about 2 L of water per day, our implicit use of water is about 2500 L/day for an average Indian, and a whopping 7000 L/day for an average American!

rivers. But are we truly up to the challenge? We have diverted away a big part of the water, dammed up its flow at frequent intervals, destroyed the watershed that nourished it, and used it to convey our waste. Even when we go to worship the river, we end up dumping waste into it. With the best of intentions, ironically, our current Prime Minister and his ensemble kick-started the new plan to clean up the Ganga by performing a puja and tossing flowers and offerings![1] We need no less than a cultur-

1 NDTV Article: http://goo.gl/oGkHb4

al revolution to clean up the Ganga! A few thousand crores here and there are likely not going to make it, cosmetic surgery perhaps. We have a tendency to admire and revere our old cultural traditions, pilgrimage in millions to bathe in the river, dump flowers, waste, and even partly cremated dead bodies as part of our religious traditions. But no great civilisation can prosper without adapting to the changing needs. Our cultural practices have to change with time. What were possible, and even sustainable, practices 1000 years ago with a population of only a fraction of what we have today, can no longer be supported by the rivers today and we can see it vividly in its decline.

The picture above is of a small river in Nagpur I took last year where we were setting up sampling stations to monitor for toxic chemicals widely used for mosquito control. Unfortunately, the river is no more than an open sewer at this time, with trash all over and devoid of vegetation, which ends up causing massive erosion along the banks. While there is water in the river, the quality is so degraded that it is not only unsuitable for drinking, but also unsuitable for irrigation, industrial use, or supporting the aquatic ecosystem. The dissolved oxygen was practically zero in the river! There are no fish in some of these degraded rivers, and with the fish gone, there are no predators to be seen, like eagles, monitor lizards and otters. The highly endangered Ganges River Dolphin is a rare sight now! Then there are things that we do not see: metals and other toxic chemicals that not only impact aquatic life, but also human health. A big part

We have a tendency to admire and revere our old cultural traditions, pilgrimage in millions to bathe in the river, dump flowers, waste, and even partly cremated dead bodies as part of our religious traditions. But no great civilisation can prosper without adapting to the changing needs. Our cultural practices have to change with time.

of our food supply still originates from our water bodies and toxic chemicals like mercury and pesticides accumulate in the fish we eat causing long-term health issues like cancer.

The solutions are not all technological. India always had access to the appropriate technology and enough qualified engineers to do this right. What we need is political will and leadership that is able to mobilise the masses into a mindset that changes social practice to what is sustainable today. Not surprisingly, when you look at who has been most instrumental in bringing change in India when it comes to water, the internationally recognised names that come up (winners of the prestigious World Water Prize) are all social/political activists! – Rajendra Singh (2015) for his innovative water restoration efforts and improving water security in rural India; Bindeshwar Pathak (2009), founder of Sulabh International, for his work in the sanitation field and social justice; Centre for Science and Environment under Sunita Narain(2005) for its contribution to build a water-literate society; Madhav Atmaram Chitale (1993) for getting India's decision makers and strategic planners to think of water as a resource whose quality and availability need to be safeguarded – a tall order indeed!

I am optimistic that we will be able to do this right. Every society goes through a self-realisation and re-evaluation of its priorities. In the heyday of manufacturing in Pittsburgh, USA, one of the rivers was so polluted with floating oil that it would often catch fire! This has changed drastically now. With prosperity and growing awareness, the citizens have demanded better and political will has followed through. I see that happening in our country as well, and we are already seeing improvements in many places. I just hope that we learn from others' mistakes and are able to move quicker through the process of renewal of our thinking about water.Perhaps there is an opportunity for us at IITB to begin an initiative to restore the glory of our namesake lake, use it as an educational opportunity for the students, and set an example for the rest of the country to follow. ♦

Upal Ghosh
B.TECH. CHEM E, '89

Upal Ghosh currently teaches and performs research in environmental engineering in the US. The focus of his research group is on the fate, effects, and remediation of toxic pollutants in the environment. He is also the president of a start-up company for environmental remediation. He was an active member of the Wildlife Club at IIT and continues to maintain his interest in nature.

Saving India's Rivers and Riverine Ecosystems

JAGDISH KRISHNASWAMY

The Prime Minister in a speech some months ago very rightly remarked that "future generations will not forgive us for the manner in which we have treated our water". It would be really nice if this concern was also extended to the plight of India's last remaining free-flowing streams and rivers. The dominant paradigm is that rivers which flow freely all the way to their estuaries and deltas do not serve any purpose and one often hears politicians and bureaucrats stating that so much water is going "waste" into the Arabian Sea. The ecosystem functions, ecosystem services and livelihoods that rivers and streams provide to communities is rarely mentioned.

No one doubts that rivers may have be to tapped and hydrology modified for human use. Many of the gains in agriculture and hydropower generation in India are from dams, barrages and reservoirs. However it is now time to look at the costs of further large-scale transformations on the last remaining free-flowing stretches of rivers and streams and question our entire approach to water management in the country. The growing evidence from negative impacts of barrages and dams on downstream ecosystems, ecosystem services and livelihoods including impacts on productivity of estuaries and deltas should be carefully assessed by all stakeholders before planning any new transformations.

All over India, from small headwater streams in forested mountains to large rivers, projects for hydropower generation, abstraction of water for industry, towns and cities, and even large-scale inter-basin water diversions are ongoing and planned. Add to that the polluted state of our major rivers, and we can imagine the magnitude of the problem.

Some of these projects will, by design, introduce an artificial diurnal cycle into stream flow with pulses of water released after the power generation cycle that is a multiple of any natural diurnal fluctuations. The small hydropower projects (SHP) which are categorised as "green energy" also often result in diversion of water through pipes and canals, leaving the original stream dry for up to one km or even a few km. The impacts on native aquatic biodiversity, riparian ecosystems and some local livelihoods can be substantial. And when several streams are tapped, the cumulative impact can be irreversible and can cause extinction of endemic species in the river basin.

India is facing uncertainty and variability from changing climate and so is the competition and conflict over access to water among sectors and states. The Indian monsoon has been declining since the 1950s, and extreme rain events are increasing in some parts of the country. The spatial and temporal uncertainty in the rainfall regime is best illustrated by what we saw in the country this year: drought in some parts, floods in others and areas with crop failure subsequently undergoing intense

Image Source: Frits Ahlefeldt- www. landscapesofunderstanding.com/photo/404/Happy-fish-in-river-Color-illustration.html

rain and floods. There is broad agreement that our rainfall regime is changing in complex ways. Furthermore the failure of climate models to simulate observed trends is worrying, casting doubt on their future projections.

These trends need to be considered when large-scale inter-basin transfers are being implemented or planned. These inter-basin transfers are based on the assumption that "surplus" water in some basins (in the wet season) can be diverted to other "deficient" basins. The role of peak monsoonal flows in sustaining downstream ecosystems and livelihoods, especially the fisheries in deltas, estuaries and shallow marine ecosystems, is ignored. These ecosystems depend on sediment, nutrient and freshwater flows to maintain the unique salinity and biogeochemistry regime that underpins their productivity.

In most cases, water scarcity problems have been addressed by supply augmentation either through creating additional seasonal storage or diversion from neighbouring basins.

In the context of the Western Ghats, numerous inter-basin transfer projects have been proposed by state and central governments including the National River Linking Project (NRLP) to divert 'supposed' surplus water from the west-flowing rivers to the scarce basins of east-flowing rivers to meet drinking water, irrigation and energy demands. However, the notion of 'surplus' and its estimation in a river basin is often based on limited data, flawed methodologies of environmental flow requirements, non-utilisable river flows and recurrent floods which discharge into the Arabian Sea. The whole engineering-dominated discourse on "utilisation" of river waters vis-à-vis ecological and environmental functions and ecosystem benefits of free-flowing rivers from headwater to estuaries is being questioned.

Many scholars now argue that the water surplus assessments conducted as part of NRLP have ignored a whole range of ecological, environmental and social issues. The methods used to estimate the environmental flow requirements (EFReq) and in stream utilisation (water demands) of stream flow to arrive at the surplus followed the guidelines proposed in the India Water Policy, 2002 and draft Revised India Water Policy, 2012. These methods applied for estimating EFReq are scientifically outdated and application of new methods for understanding environmental flow 'regimes' (EFReg) could classify these

large storage and diversion projects either environmentally damaging or socially unjust/inequitable. Traditional methods of estimating EFReq used either historical or modelled minimum discharge in the river as essential flows for environmental benefits, and typically are some percentage of the total annual discharge or twice/thrice the minimum discharge (measured/modelled) in the stream in an average year. In India, the concept of impacts of river flow regimes on specific components of aquatic biodiversity and ecosystem services downstream is a very recent area of research enquiry and even the concepts and methods are largely hydrologically and statistically driven rather than comprehensive approaches encompassing taxa-specific biology, aquatic ecology, ecosystem services and livelihood dependencies.

The role of flow 'regimes' and 'flow variability' in maintaining ecologically and socially beneficial habitat is very recent. For example, tropical estuarine areas free from major developmental projects have been known for their extremely productive fisheries. All along the Indian west coast, the estuarine banks are densely populated with hamlets dependent on fisheries, including shellfish. There are hardly any rigorous studies to ascertain the importance of unaltered hydrologic regimes and economic returns from fisheries to in stream and downstream communities. Even rarer are studies which assess the negative impacts of altered flow regimes due to hydroelectric projects or diversions in any of the several rivers from the Western Ghats.

Freshwater, estuarine and deltaic ecosystems and their biodiversity and ecosystem services are the most threatened in India due to dams and upstream diversion for agriculture and industry, overexploitation of groundwater and pollution of surface water. In addition, growing urbanisation and the need to supply water to villages and towns is likely to place even greater demands on the limited supplies of unpolluted water that emerges from forested highlands and wetlands. The plan to interlink rivers is also raising concerns about impacts on biodiversity and ecosystem services, apart from its sustainability under the current climate and future climate change.

The National Water Policy has mandated that ecological and environmental flows should be maintained in rivers, but we do not have rigorous scientific guidelines for assessing flow regimes for specific riverine ecosystems

and ecosystem services. We do not have a management and policy framework that imposes efficiency on competing water use in industry, cities and agriculture to enable allocation of water for maintaining ecological and environmental flows.

Ideally, multi-stakeholder and inter-disciplinary approaches are needed to estimate ecological and environmental flows in selected river ecosystems and design an adaptive management plan that reconciles ecological flows with other competing uses, and also privileges sustainable use of precious unpolluted water for drinking water, reduces water use in agriculture, promotes recycling and reuse by industry and in urban areas. Furthermore this assessment must take into account ongoing and projected future trends in climate.

Saga of the Son

There is legitimate concern about projects on the last remaining free-flowing streams and rivers, but what about the rivers that are already regulated and managed (the majority of rivers in most parts of India) in particular ways? Can we manage them to enhance biodiversity and ecosystem services?

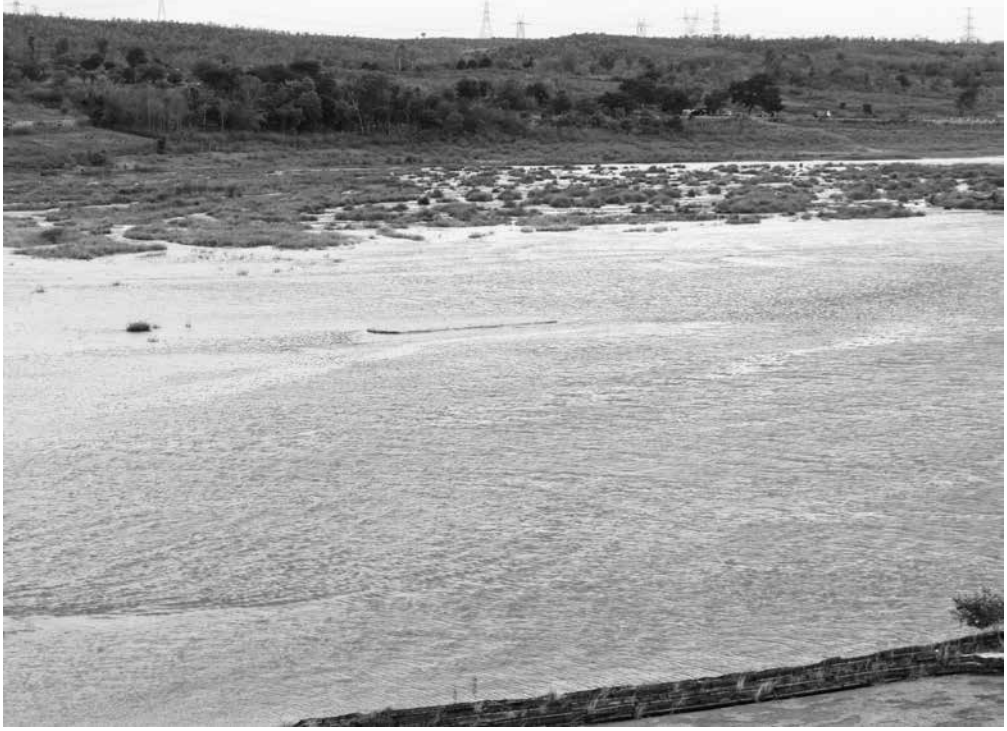
To illustrate the challenges of maintaining ecological flows, I will cite our experience from the Son River, a tributary of the Ganga that originates from the highlands in central India. The Son River had river dolphins, *gharial* crocodilians, freshwater turtles, otters and a thriving fishery that sustained communities of fisher folk.

The Son was also prized for the quality of its sand. The first major change and barrier was the Indrapuri barrage in Bihar, completed in 1968, which reduced the Son to a trickle in the dry season downstream. Dolphins were probably the first casualty of this barrier and discontinuity of flow. However the Son upstream of this barrage was still a thriving riverine ecosystem. A 200 km stretch of the river and part of its two main tributaries, Banas and Gopad, was declared the Son Gharial Sanctuary in 1981. The Son Gharial Sanctuary is home to a number of endangered species, with the flagship species being the *gharial* (*Gavialis gangeticus*), narrow-headed softshell turtle (*Chitra indica*) and Indian skimmer (*Rynchops albicollis*). All three species are river specialists and their breeding ecology and reproductive success are closely linked to the seasonality of flow regimes and the availability of undisturbed nesting sites like large, high sand deposits and emergent sandbar habitats.

India is facing uncertainty and variability from changing climate and so is the competition and conflict over access to water among sectors and states

But in the last ten years, this 200 km riverine biodiversity hotspot was transformed. The Bansagar Dam (whose waters are to be shared between MP, UP and Bihar) was completed in 2006 after decades of planning and construction. As the gates were shut and the reservoir started filling, the stretch of the Son River downstream of Bansagar and upstream of Indrapuri was subject to major changes in flow regime and sediment dynamics. As the reservoir filled up, the river downstream was choked of dry season flows and sediment. Subsequently once the reservoir was filled up, a new regime of flows subject to releases of water from the dam for irrigation and for hydropower generation started. Sand mining of the exposed riverbed in the dry season proliferated and mining mafias defied state authorities. Successful *gharial* nesting was restricted to only one site along the entire stretch.

Meanwhile, the water of tributaries downstream has been allocated for a series of thermal power plants, cement factories and townships, one of which has already tapped



the Gopad tributary.

I was part of a small team consisting of myself, wildlife biologist Ravi Chellam, and dedicated aquatic ecologists Tarun Nair and Suyash Katdare, who had to advise the MP authorities on how much water to release from Bansagar Dam to maintain "ecological flows" in the Son Gharial Sanctuary. Bihar's share of the Bansagar water flows through the Son Gharial Sanctuary. We first found out from our independent measurements that the claim of the authorities that a discharge of 50 m^3/s that was supposedly maintained in the Son downstream of the dam was not correct. It was a fraction of that! We also discovered that the Gopad and Banas tributaries were now the lifeline of the Son in the dry season.

Our basic idea was to try to relate quantitatively release of water from Bansagar Dam to maintenance of desired water levels at breeding and nesting sites of the endangered *gharial*. Using this, we would propose a reservoir release regime that would be least damaging.

However, as we worked with a very sincere forest officer and a dedicated team of ecologists on the ground, we experienced first-hand the complexities of maintaining ecological flows downstream of reservoirs.

On 20 February 2015, the Bansagar Dam authorities informed that they would release water from the Bansagar Dam for Bihar state at a discharge rate of 170 m^3/s from 2pm. This raised water levels in the sanctuary by over 50 cm over a couple of days, an event that would usually not happen at this time of the year, inundating basking and nesting sites of the *gharial*.

We protested and requested them to reduce the rate of discharge, and finally it was reduced to 125 m^3/safter four days. This release regime did connect isolated pools and *gharials* were able to move from one site to another along the river, and even excavated trial nests, but it was a short-lived connectivity, as the dam gates were shut on 9 March 2015, and no successful nest emerged in any new site. Such movements can also leave *gharials* stranded in less protected sites once the dam gates are shut and water levels recede.

On 6 April 2015, the dam authorities informed us of their plan to release water again due to demands from UP and Bihar. We requested him to defer any releases till we

discuss the matter with the Forest Department, particularly since skimmer nesting had commenced on emergent sandbars and islands in the Son Gharial Sanctuary. Following Forest Department intervention, Bansagar Dam authorities provided assurances that no water would be released in this period. They furthered offered to make available, on demand, up to 3 m3/s of water for maintaining river flow in the sanctuary. However, the sudden opening of a smaller dam on the Gopad River tributary that caters to the thermal plant resulted in the drowning of the first clutch of skimmer nests and abandonment of nesting sites in the one of the important nesting sites in the fourth week of April 2015. While the increase in water levels was relatively small (< 15 cm), it led to the submergence of a large part of the emergent sandbar that was used as the skimmer nesting site, and the subsequent disruption of their first nesting effort.

Finally, on 8-9 June 2015, the Bansagar Dam authorities were ordered by their superiors to start releases and this raised water levels by 78 cm, and this release of water from Bansagar Dam resulted in the total loss of skimmer nests at four breeding sites. Even mounds created by the sanctuary management, as an emergency measure, a day earlier could not prevent the inundation of nesting sites. However the *gharials* fared better as the 2015 season produced 3 nests in the only breeding site, and 85-90 hatchlings emerged between late-May and early-June. But skimmers had a bad year, despite their attempts to nest for a second time in the same season.

This is just to illustrate the complexities of managing reservoirs for ecological flows all over India. In the future, we will have to think of innovative and creative ways of restoring sediment deposition to riverine ecosystems, which will be a big challenge.

Conclusion

Ecological and environmental flow regimes should become an integral part of any future project design, rather than an afterthought. Ultimately, ecological flows, water stress and conflicts over competing demands on scarce water resources can be resolved only by promoting recycling, reducing water use and wastage of water in all sectors: agriculture, industry and in cities and towns. Furthermore, high quality water from ecosystems must be at a premium and industry must not be able to get it cheaply as has been the case all along.

In conclusion, I would like to dedicate this piece to the memory of Professor Ramaswamy Iyer, former Union Secretary, Water Resources, Government of India, who passed away on 9 September 2015. He was the architect of the first National Water Policy and wrote on sustainable water management with insight and foresight. He belonged to the dwindling tribe of bureaucrat-scholars, and he will be missed by all of us who are concerned with saving India's rivers and their ecosystems. ♦

Jagdish Krishnaswamy
B TECH. CIVIL E, '89

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Irrigation and Electricity: Escaping from the Trap that it is Caught in

SREEKUMAR N

What has the topic "Irrigation and Electricity" got to do in an issue featuring "Water"? Quite a lot, in my opinion.To begin with, more than 80% of the total water use in India is for irrigation, with the next biggest consumer (drinking water) using around 7%. But why bring in "electricity"? Not because I am an electrical engineer or work on energy policy, but because electricity is one of the major drivers of irrigation, though there are other drivers too. One can never understand any issue without looking at all the major dimensions (in more technical language, state variables!). Just as irrigation is a major dimension of the water conundrum, it is impossible to understand irrigation without also looking at electricity and in fact, a few more variables. So please read on.

Why is 'irrigation and electricity' important to an engineer?

Growth in irrigation has catalysed the significant increase in food production after independence. Not many would know that groundwater irrigation plays a major role compared to the grander canals and historic tanks. Tank and canal-based irrigation dominated till about 1975, when groundwater-based irrigation overtook them to support the highest irrigated area. Since tank-based irrigation slowed down and canal-based irrigation grew at a slow rate, today groundwater-based irrigation supports twice the area irrigated by canals and tanks put together. While I endorse promoting rain-fed agriculture, reviving community tanks and selective use of canals, it is important to realise that groundwater-based irrigation holds the key to food security in this country.

And what powers groundwater irrigation? Estimates of numbers have to be taken with a pinch of salt, but what is reported is this. There are around 2.8 crore pump sets in India, and nearly 2 crore run on electricity and rest on diesel. A very small number are manual/animal operated or, more recently, solar powered. The annual growth rate of electricity-based pumps is around 3-6%. It is clear that electricity-operated irrigation pumps are the drivers of groundwater-based irrigation. Electricity consumption by these pumps is around 20% of the total consumption in the country, a close third after industry (42%) and domestic (24%) consumption. It is also to be noted that the percentage of agriculture consumption is as high as 30-40% in some states.

There should be no complaints about such high consumption, since it meets the important need of irrigation, closely linked to food security and livelihood of farmers. But the catch is in the multiple traps that this area has gotten into, due to the short-sighted actions of different actors who work at cross purposes to each other, often contributing to positive feedback loops. If one wants a metaphor to describe the trap, I would choose a traffic jam.

Image credit: Image is sourced from www.unsplash.com

Those on the move – trucks, buses, cars, autos, two-wheelers, cycles, animals or pedestrians – act in their own immediate self-interest, which is to get as much ahead as they can. The regulator – be it the traffic police or signal – often has no credibility, authority or innovative ideas to break the logjam. The planners are caught in the wishful thinking that a wider road, flyover or footbridge will solve all problems forever, or they are forever experimenting with new traffic rules, re-routing of traffic or re-allocating road space. Traffic jams often grow in size and complexity, caught in a positive feedback loop. Today, 'irrigation and electricity' is caught in a similar trap with no one having clear ideas on how to break the trap. Like all real-life problems, this issue has many dimensions in addition to the technical dimension and it is a worthy challenge for any of us to work on.

The multi-dimensional trap

There are many dimensions to the trap that irrigation and electricity is caught in. I describe three –electricity, water and poverty. It becomes evident that all actors – farmers, electricity companies, state governments and society at large – are unhappy with each other and the trap they find themselves in.

Electricity dimension

As noted before, groundwater pumping using electricity is the most prevalent mode of irrigation. Electricity tariff for agriculture is low and is free in some states. This leads to multiple problems. Farmers tend to overuse water since electricity is cheap, leading to depletion of groundwater. Farmers also do not invest in efficient pump sets, thus increasing the electricity consumption. For every unit of energy supplied to a farmer, electricity companies lose around ₹4-5. Therefore high consumption by farmers leads to higher financial losses for electricity companies. This makes the electricity companies neglect the quality of supply to the farmers, which means that there are frequent power failures and long time to restore supply.

What do the farmers do? Since power

can come and go any time, many farmers bypass the protection mechanisms provided for the pump set. This and the low voltages or frequent power failures lead to burnouts of motors. Farmers often leave the pump on and there is over irrigation; many install higher capacity motors than what was sanctioned and purchase low quality pump sets. To reduce the impact of consumption by farmers, as a matter of policy, farmers are given limited hours of supply (7-10 hours, often during

It is clear that electricity-operated irrigation pumps are the drivers of groundwater-based irrigation. Electricity consumption by these pumps is around 20% of the total consumption in the country, a close third after industry (42%) and domestic (24%) consumption.

night), when demand from other consumers is low. This is quite inconvenient for the farmers and worse, there are complaints of deaths due to snake bites or shocks while visiting the field for irrigation. All these make farmers unhappy with the state of affairs.

This is the electricity trap. Both the electricity companies and farmers are unhappy with each other and do not cooperate to break the logjam. Both try to take short-term advantage of the situation. Electricity companies neglect the quality of supply to farmers, ration new connections to pump sets and make no attempt to do field surveys to assess the actual number of live connections. State governments are expected to compensate the electricity companies for the financial loss in supplying electricity to farmers. Since most agriculture pumps are not metered, electricity companies exaggerate the consumption estimates, since that helps to claim higher compensation and also to project lower energy losses. Farmers also take shortcuts and all these complicate the problem, in a positive feedback loop.

Water dimension

As mentioned in the previous section, cheap electricity leads to greater extraction of water. With deepening depth of wells, the quality of water suffers. Considering cheap availability of water and aided by price signals, farmers opt for water-intensive crops (sugarcane or rice) even in dry areas. There is competitive digging of bore wells, with each well going deeper than the other, hoping for better water yield. In most places where groundwater is scarce, this trend depletes the water table. Farmers end up spending a lot of money in digging and repairing wells or pumps, though expenditure on electricity is low.

The replenishable groundwater resources have been estimated and the entire country has been classified by Central Ground Water Board (CGWB) into categories, namely: over-exploited, critical, semi critical and safe blocks, based on the net groundwater stock situation. According to CGWB, the number of over-exploited and critical blocks in India has increased significantly. Their total was 4% in year 1995, but has grown to 19% now. For many states with high percentage of critical districts/blocks, such as the Punjab and Rajasthan, annual draft of groundwater for the state as a whole, 90% of which is for agriculture, is much more than the annual replenishment of groundwater.

Poverty dimension

Agrarian distress and farmer suicides are very much in the news. In the past two decades, there have been around 15,000 farmer suicides every year, sometimes as high as 18,000 per year. This works out to around 15% of all suicides and sometimes as high

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as 18%. Most suicides are due to high debts, caused by crop failure, repeated bore well digging, etc.

It is to be noted that nearly 85% of the land holdings are marginal or small (less than 2 hectares) and these farmers own 63% of the wells. Small farmers are typically in a tight financial situation (with limited access to low interest credit and high discount rates) and will not be keen to invest in efficiency or pump protection devices. State governments provide subsidy for power supply, irrigation, etc., but our studies show that a high amount of this subsidy is unfortunately cornered by big farmers, due to the faulty design in subsidy policy. Another shocking point to note is that around 10,000 people die every year due to electricity shocks, most of them in rural areas, and most of them farmers. This is due to poor enforcement of safety norms by the electricity companies, poor quality of supply and risk taking by the people. In these times of growing penetration of high technology and plans for smart cities, this is indeed a matter of shame.

Is this then a story of hopelessness? NO!

It is clear that 'Irrigation and Electricity' is caught in an ever-tightening trap due to neglect and half-hearted single dimensional efforts. The situation is indeed grim, but it is heartening to see that there are many people doing many things to improve the situation. A concerted, sensitive effort with an integrated, consensus-building approach can surely solve the problem. To illustrate this, I mention some of the initiatives under way and my suggestions on how to improve on them.

In the area of electricity, there are measures like separating agriculture feeder from rural feeder; replacing inefficient pump sets with efficient ones or a 'super pump', which is efficient as well as fail-safe; installing capacitors on pump sets; and introducing electronic metering at Distribution Transformer level for calculating consumption. These are welcome and their implementation can be improved with public consultation and dialogue. Government has plans to introduce solar power to supply agriculture, which can ensure quality

Image credit: Image is sourced from www.unsplash.com

electricity during the day time. There are plans to install 1 lakh solar pumps in this year and the target is to have 10 lakhs by 2021. Solar pumps are a good idea, especially in areas where water is available very near the ground and where the electricity grid coverage is low. But for the majority part of India, we have been suggesting solar-powered agriculture feeders as a more cost-effective and sustainable option.

In the area of water use, there are many initiatives at the ground level by way of community-led watershed development; efficient sprinkler or drip irrigation systems; bore well recharging; repairing traditional tanks; introducing new methods of cultivation like SRI which reduces water usage; encouraging crop rotation; promoting organic farming; etc.

What is needed is to evolve an integrated approach including the dimensions of water use, land use, review of other inputs into agriculture (pesticides, fertilisers, seeds, etc.), improving the lose pricing and marketing of agriculture produce, easing credit availability, improving the quality of electricity supply and increasing efficiency of electricity use. This can lead to reduction in water and electricity use, while ensuring sufficient sustainable safe food production. And this is possible through dialogue involving farmers, electricity companies, Irrigation and Agriculture departments, researchers and policy makers. All have a lot to learn from each other to understand the state variables and on how to escape from the trap.

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B. TECH. ELEC E, '84

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Water: Urgency, Challenges and a Few Concrete Steps Towards Resolution

NIKHIL TIKEKAR

Water supply is monsoon dependent. Our water needs have grown immensely since the last severe drought ~ 40 years ago but there hasn't been proportional growth in buffers (storage) and in efficiency of utilisation. Some of the existing buffers are shrinking i.e. not recharging within a reasonable time. Present buffer management won't be able to handle even one major monsoon failure, consecutive failures would lead to immense suffering for many, social instability, and have long term economic impact.

However, sustainable consumption is possible, including planning for 2-3 monsoon failures. How? Let's take a brief look at the water delivery chain, identify known inefficiencies and needed solutions, review a concrete effort in that direction at IITB and various avenues (for us!) to contribute.

Overview of Key Factors in the Water Delivery Chain

Monsoon rain and Himalayan snowfall are the primary inputs. Distribution is through rivers, streams (including underground flows), canals, and pipes. Lakes, ponds, underground aquifers, and glaciers are natural buffers that provide water beyond the rainy season. Then there are human made storage schemes – large and small dams, and on a smaller scale, local rain water harvesting for farms and communities. Flow into the sea, evaporation, and seepage (including pipe leakages) are the main sinks.

Current utilisation of water is quite inefficient. Besides, it is associated with a lot of wasted energy and contributes to environmental pollution as well. Some of the issues that need to be addressed are:

- Drinking / daily water requirement is a very small fraction of the total but is not easily accessible
- Dam capacity reduction due to accumulated silt
- Ad-hoc dam water release, especially under political/public pressure
- No serious effort to reduce storage/distribution losses (evaporation, leakage)
- Unsustainable extraction due to lack of regulation of borwells
- Pollution/chemical poisoning of wells/aquifers/ponds
- Inefficient last-mile irrigation
- Water-inefficient cropping; wrong crops in wrong locations
- Insufficient rain-water harvesting
- Inefficient and excessive use of water in the massive public/private construction boom
- Leaking taps and tankers
- Vested interests preventing replacement of tanker supply with pipelines
- Growing number of bathtubs, showers, flushes, lawns, resorts, golf courses etc., which are water guzzlers
- Lack of water recycling facilities in indus-

trial / transport / commercial setups

Towards Sustainable Solutions

In short, we need to increase the sustainable capacity (with minimal human and environmental impact), reduce distribution losses, increase utilisation efficiency, reduce unsustainable demand, plan for multiple monsoon failures, and make water easily accessible to all.

Water is a shared resource. Government makes policies, implements buffering and distribution schemes. However, it can use assistance in policy direction; planning solutions; techniques for measuring, gathering, analysing, and reporting water data; better implementation tools & methods; better buffer/storage utilisation protocols that anticipate failures; and evaluation, auditing of its completed work. End users too can benefit from information and knowledge, tools and products for efficient/sustainable utilisation of water.

The complexity & severity of this issue is highly under-appreciated and solutions/techniques (e.g. scale and methods for rain harvesting) are not widely known. No government policy or implementation can succeed unless everyone supports sustainable consumption. There is an urgent need to create this awareness at all levels.

Who Will Implement these Solutions?

Government, its agencies and contractors, entrepreneurs, engineering colleges, NGOs, end users and you!

An Example - Concrete Steps Towards Solutions (and how you can help)

This one focuses on (not exclusively) rural areas. Why? Farms consume 80%+ of water; many villages lack easy access to drinking water; rural areas are the most affected by droughts. Unlike rich municipalities, village councils can't afford to hire expertise – they rely on state agencies who don't have it.

A. Framework:

The biggest impact would come from influencing government actions (it owns, manages, and distributes water) – making them more efficient and accountable. There is a huge shortage of awareness, modern knowledge, and techniques and skills related to managing water resources. One has to acquire it via empirical field studies and trial error (not from books/simulations)- it's not a very appealing hard work. IITB has built up a good amount of base over the past few years and now has a Technology & Development Solutions Cell, TDSC (seeded by C'87), dedicated to that task.

B. A Sample Project:

How to measure water demand for a village/farm, how to see whether crop pattern across seasons is sustainable, what algorithm/protocol should be used to release dam water (present method is inefficient), how to monitor usage of groundwater via borewells and model recharge times so that it can be eventually regulated and made sustainable, how to build/display information in GIS for use by the administration, how to implement logistics of water delivery to drought affected villages (e.g. location of the water source from where tankers collect water and their routing etc.), analysis of failed drinking water schemes.

C. Impact of Projects:

The impact of these projects have been manifold: Knowledge and skills have been developed that can't be built in any other way. Pilot projects (eg. Construction of mini-dams) have benefited local communities/villages. Effective project implementation has resulted in the much needed policy of the Government of Maharashtra that welcomes colleges/others to participate and influence its project planning and evaluation. The future use of TDSC know-how would scale beyond just a few pilot

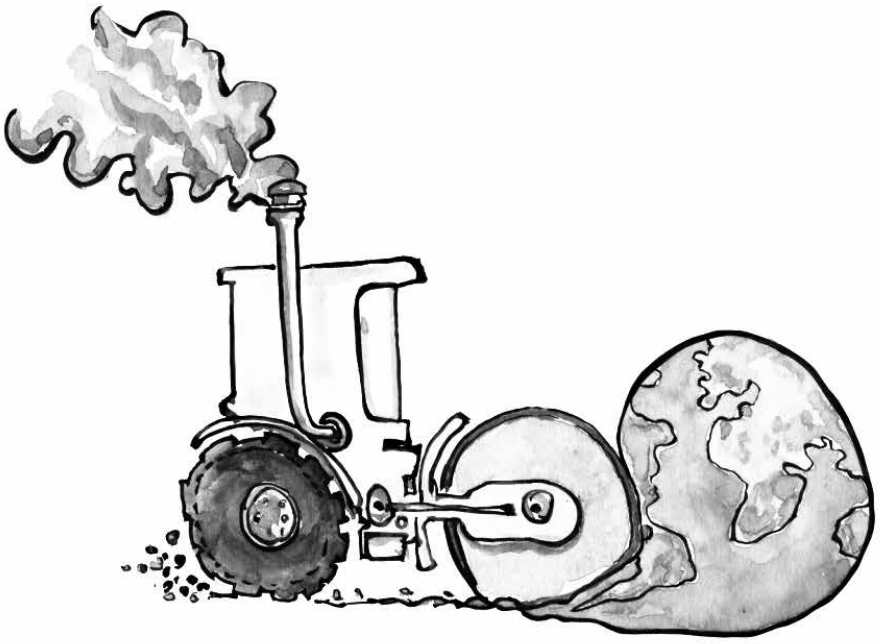


Image credit: Frits Ahlefeldt: http://hikingartist.com/2014/05/05/steamroller-globalization/

communities. The success of these programs could contribute to nationwide emulation.

The know-how developed at TDSC has utility beyond TDSC/other colleges improving government schemes. This can be also used by NGOs/corporate charities or by entrepreneurs. The difference between doing things and doing them properly matters a lot for water schemes.

D. Your Contribution - A Few Possibilities

Join TDSC: part-time technical contribution, coordination of projects, execute sub-projects, generate research ideas.

Fund specific time bound (typically 2 years) projects.

The need for such work is urgent and provide many intellectual challenges. However, monetary rewards / research publications may not be available immediately. Special prizes and incubation support for water-related projects and ideas will make this area appealing.

Generate ideas, incentives and triggers to create a viable market place to reduce dependence on the state; lobby the government for favourable policies.

Nikhil Tikekar
B. TECH, ELEC E, '85

Nikhil has worked on parallel processing and reliable distributed computing architecture for telecom with Center for Development of Telematics in Bangalore and Delhi (1985-1989) and L.M. Ericsson in Dallas, Stockholm and Bangalore (1989-2014). Among other things, he is trying to grasp the immensity of water related challenges.

Mahatma's Mandate: Sanitation

Image credit: Image is sourced from https://unsplash.com/

Almost 70 years after independence nearly 600 million Indians do not have access to proper sanitation. A recent technology development brings clean, eco-friendly, and affordable sanitation to the masses.

The recent elections highlighted the importance of sanitation, with competitive polemics and rhetoric being bandied about. Actually that is rather welcome. Indeed, the first Prime Minister of India said, "The day every Indian has toilet to use, I will consider India a developed nation." The father of nation has been widely quoted as having said, "Sanitation is more important than Independence."

The Industrial Design Centre at IIT Bombay has now designed a toilet that does not require water for flushing. The design is hence called Dry-San for dry sanitation. The research and study has been funded by Ministry of Drinking Water and Sanitation.

Professor Munshi, Industrial Design Centre, IIT Bombay explains the design. The toilet has two levels of pit, a deeper pit and a shallower pit, one above the other. The shallow pit and deeper pit are separated by means of inclining slope, created through structure of bamboos. The pan at top could be of any material, but is presently proposed to be of stainless steel for lasting value. The design has a footrest for heels to ease sitting for elderly as well as for appropriate targeting of solid waste.

The solid waste falling into shallow pit slides over bamboo support. The deeper pit provides aeration and also allows water separation. Aeration also occurs at shallow pit thus allowing rapid decomposition.The rapid decomposition along with separation of water from bottom would reduce the weight of waste by almost 90% and the decomposed pathogen free waste oozes from the other edge of shallow pit is ready to act as manure.

The design of the shallow pit also envisages multiple levels of baffles in the shallow pit, to slow the descent of waste thus firstly allowing more time for aeration of waste and separation of water from waste. Secondly the baffles would also separate decomposed waste from fresh waste. Interestingly, the design separates urine from solid waste by collecting it from the front end of the pan into a separate container. Vapour odours are kept away from air by means of polystyrene balls that float above and allows retention of fertilizer value.

The design is already being used at one place at IITB for few months, proving its utility and practicality. The next step would be to test the design at 100 locations before a massive roll out on confirmation of suitability. While fabrication costs are presently around Rs. 30,000, mass production would bring down costs to below Rs. 10,000 thus making national implementation feasible.

GIS based Flood Assessment

Floods in Mumbai due to heavy rains on 26th July 2005 took a toll of more than 400 lives and resulted in economic loss of over Rs. 5000 crore. The events of that day highlighted the importance of designing constructions for floods. A flood model that can predict the amount of flooding in a region could be of great utility in minimising the damages.

There are several flood models that provide information on the water levels and areal extent of inundation in a region and thus assist assessing vulnerable areas. However these models are complicated, costly, data intensive and require high level of expertise to simulate. Hence, the benefit of use of advance datasets cannot be realized by the stakeholders or the local communities who are directly affected by flood events.

But things are set to change. A new work from Civil Engineering Department and CSRE at IIT Bombay is geared to make flood assessment easy. The work integrates a flood assessment model with web based Geographical Information System (GIS) framework to create a web enabled tool that is easy to access, use, and does not require special hardware or software system at user end. Prof. Eldho and his team are of the view that development of such a web GIS based distributed flood assessment model has not been reported elsewhere earlier, in the country.

The model is presently geared for urban cities in coastal Navi Mumbai. Indeed the model has been tested for its application for twelve urban catchments in Navi Mumbai. The work has been sponsored by Department of Science and Technology of Government of India.

The 'Flood Tool' is easy to use. Indeed once the data sets have been populated, even a non expert user can simulate flood scenarios for different rainfall intensities and see results over a browser.

When questioned if this model could be used to predict 26th July 2005 kind of floods, Professor Eldho reminds that this would depend on availability of information regarding impending rainfall. However such information is not readily available, he adds as a caveat.

However this should not distract from the utility of model, since the web based GIS system, called Integrated Flood Assessment Model (IFAM) can still be used for giving information on possible levels and areal flood inundation extent patterns of flood at any location for different rainfall intensities. This is useful for identifying the vulnerable areas in the catchment and also to assess the capacity of existing main channels in the catchments.

This 'Flood Tool' – if we might call it that,

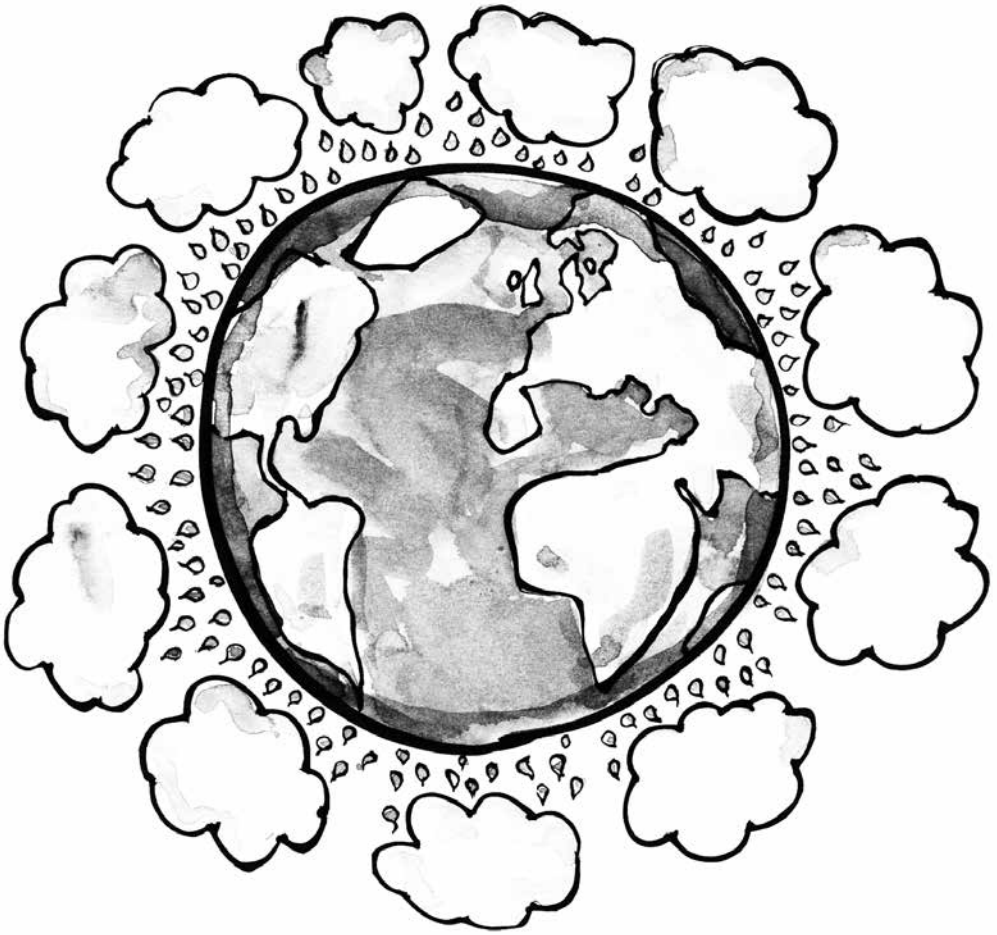


Image credit: Frits Ahlefeldt: http://landscapesofunderstanding.com/photo/1264/Earth-with-clouds-and-rain-Color-illustration.html

integrates Web GIS System developed on Java with Integrated Flood Assessment Tool developed in MATLAB. The 'Flood Tool' has to be populated with a static catchment specific data like digital elevation model and channel geometry while the dynamic data such as rainfall, tidal level, simulation time etc can be fed through a web browser.

The 'Flood Tool' is easy to use. Indeed once the data sets have been populated, even a non expert user can simulate flood scenarios for different rainfall intensities and see results over a browser. As earlier mentioned, if rainfall forecast is available, this tool can even predict the flood near real time. Otherwise also, the IFAM model can be used for various design purposes, disaster and risk management.

The team: Professor T I Eldho, Prof. E P Rao from Civil Engineering Department and Prof. B Krishna Mohan from CSRE, at IIT Bombay who are the principal investigators, while A T Kulkarni, who is pursuing his PhD in this area, and J Mohanty have been the research fellows under this project.

The Leaky Conundrum

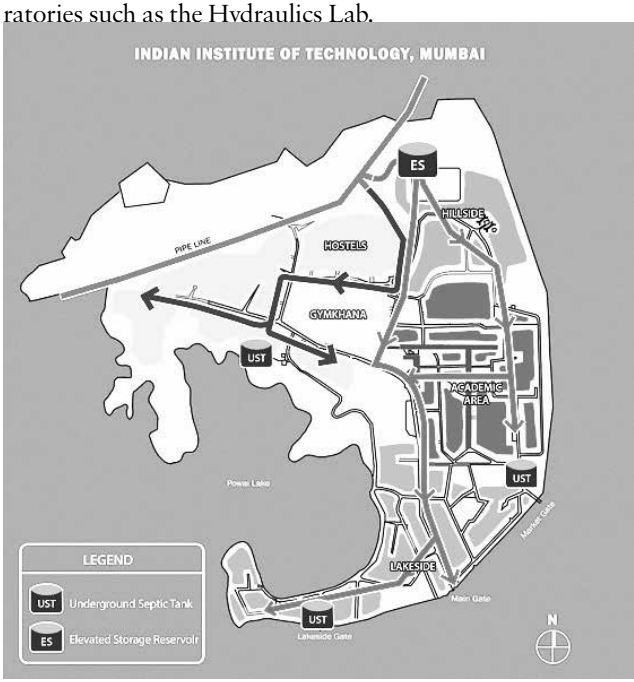
PANELISTS: ANISH GUPTA, CHAITANYA MANDUGULA, JIVRAJ KARWA, MIHIR KULKARNI, SANDEEP UPADHYAY, SHARTH MADAN, SHREERANG JAVADEKAR, VAIBHAV BHOSALE

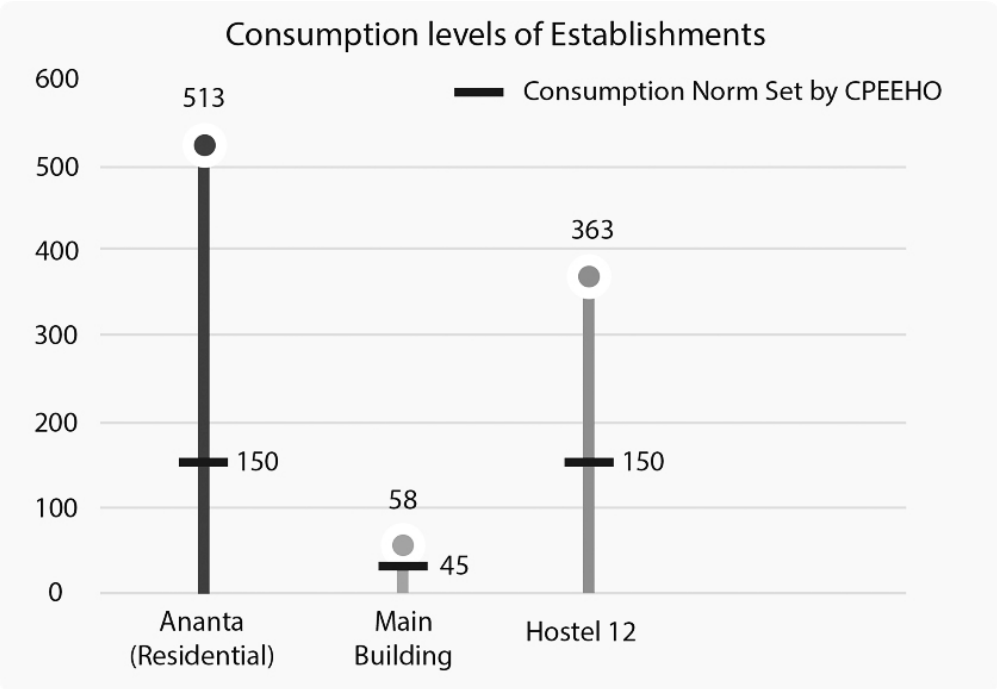
The importance of water as a precious resource in our lives can't be overstated. But do we think about how we use it? Even today, large parts of India face the problem of water scarcity. IIT Bombay is blessed in that regard as we have a 24*7 water supply. Here, we delve into the matter of water supply and usage on campus. The huge disparity between water consumption levels in insti and the rest of Mumbai shows a callous approach towards water as a resource. We also look into the ways water is being wasted and reasons thereof.

Background

The water supply network of IIT Bombay is very complex, and has degenerated into dilapidation over the years, since its laying down in 1960s. The primary source of drinking water is the Brihanmumbai Municipal Corporation (BMC) pipeline, which supplies water to the campus 24 hours a day. The Tulsi and Tansa lakes are its primary sources.

The one and only water meter of the campus is installed on this line, and it caters to two main tanks located near Hostel 15. These have capacities of four and six lakh litres respectively.There are a total of 24 borewells (secondary sources) on campus catering to gardening, flushing and water-intensive laboratories such as the Hydraulics Lab.





Per-capita consumption of water in each representative building covered in the case study, vis-a-vis set CPEEHO norms

As estimated from estate office data, the average litres of water consumed per person per day (LCPD) in the institute is approximately 358 litres. CPHEEO (Central Public Health and Environmental Engineering Organization) norms recommend the usage of water in residential areas of metropolitan cities such as Mumbai to be 150 lcpd and 45 lcpd for offices. Clearly, IITB's consumption exceeds CPHEEO norms by a jaw-dropping amount.

The current infrastructure is getting old and has already outgrown the capacity for which it was designed. The ever-increasing population in the institute has led to increasing pressure on the supply system, which operates pumps for 24 hours - an inefficient *modus operandi*.

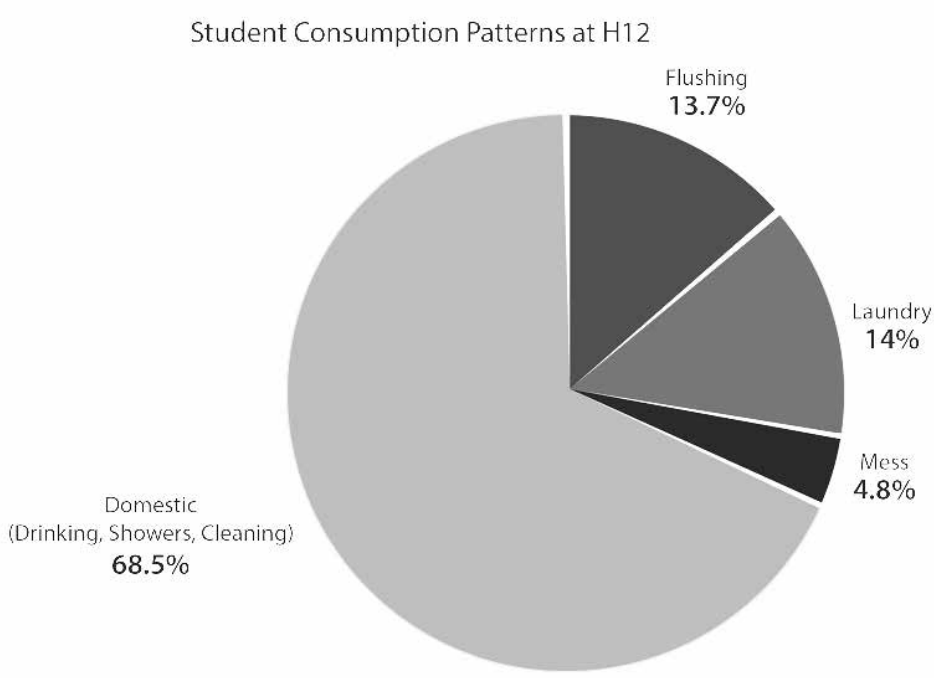
It has been noticed that the meter on the high pressure BMC pipeline gets damaged every few months due to flowing debris. Given that around 20-25 days are needed to fix it, measurements, and subsequently, water bills, for that period are merely an approximation of previous months' records.

While many recent changes have been made to the pipeline system, necessary documentation which could be used at the time of repairing is still missing. Often, senior officials at the estate office are called to address the problem whenever a complaint is registered, which increases response time.

Case studies

Comparing consumption on campus with any established norm is hard because it cannot be put in one category. Also, the absence of meters means that the figure of 358 lcpd cannot be subdivided on types of usage. However, to gather information about consumption patterns across the institute, approximate calculations were made using pipeline diameters and capacities of storage tanks.

Although corrective steps have been taken by introducing wastewater recycling systems in residential complexes, it was discerned that



Consumption of an average resident of Hostel 12 for various activities, as percent of total consumption

they are only present in recently developed complexes and are not being efficiently used. Office complexes like the Main Building fare better, but still show higher consumption than the norm.

As per preparatory studies done for Mumbai Development Plan for 2013-14 (sourced from MCGM), the actual per capita water consumption by an average citizen of Mumbai is 268 lcpd, far exceeded by IITB's 358 lpcd

Why do we consume so much?

Here, we want highlight two important reasons for such high consumption: first, the institutional wastage of water through overflowing tanks and second, individual wastage of water due to consumer apathy.

A survey conducted by the previous GSHA Abbas Ali Bohra brought to notice the fact that nearly all our hostels had overflowing storage tanks for as long as two years (see the table attached). This has now been corrected temporarily, albeit in an ad-hoc manner, where valves are changed every three months. The main reason for this provisional arrangement is that the quality of valves being used is poor. These were downgraded after repeated pilfering of good quality valves.

To quote an instance, ex-GS of H1 Ratikanta Nayak asserts that after he reported the persistent and incessant water leakage in H1 tanks to the concerned authorities, only temporary rectifications were made, and the problem persisted till the end of April 2015. This amounts to more than one and a half years. Once students declared their intent to take this issue to the State Government, however, it was resolved within a month's time.

The second issue is the indifference shown by campus residents. All too often, leaky taps in hostels are left unrepaired for weeks, on account of inaction by both general residents and authorities. For example, there exists a tap in H2 which has been slowly leaking for more than two years. A simulation done on a mildly leaking tap gave us wastage of 350 ml per minute, which when extrapolated gives a

Hostel	Does your hostel face water overflow issues in overhead tank?	Has this problem remained unsolved even after several complaints?	Does the solution done by HMU fails every time?	How long has this problem persisted?
1	✓	✓	✓	More than one & half years
2	✓	✓	✓	almost a year
3	✓	✓	✓	Since one year
4	✓	✓	✓	Yes
5	✓	✓	✓	Yes
7	✓	✓	✓	Since last 2 years
8	✓	✓	✓	14 months
9	✗	✗	✗	nil
11	✓	✗	✗	Not so frequent
10A	✓	✗	✗	5-6 months

Results of the survey on leakage of overhead tanks, conducted by ex-GSHA Abbas Ali Bohra

staggering figure of 500 litres of water wasted per day. Conservatively estimating 2 leaking faucets per hostel, this sums up to a flabbergasting figure of 17,000 litres of water wasted daily, by all hostels together. To put things in perspective, the 17,000 litres of water wasted every day is enough to satisfy the daily needs of 17 households of 4 people each, or for the sustenance of one person for about 24 years.

One underlying cause here is that water costs for students are highly subsidised. We pay Rs. 2500 per semester for both water and electricity. Considering our levels of consumption for these two resources, there is not enough monetary incentive for students to conserve water. The culture of wastage prevalent at IIT, which includes other important resources like food, can be ascribed as another reason.

The authorities have taken certain measures of late, but these seem too little considering the monstrosity of the problem. Proposals like an institute-wide water audit and use of level sensors in overhead tanks are still in the pipeline, with no specific timeline.

Finally, we'd like to conclude by saying that a pro-active approach is needed by both authorities and general residents to curb incessant water wastage. The argument we wish to make, is not to increase fees so that students feel the bite of wastage, but to bring culprits to book and impose monetary fines to reign it in. Many institutes abroad perform surprise inspections to maintain checks on consumption levels. At the hostel level, we believe students must be held culpable. Councils need to ensure that reported cases are catered to within a specified time period and hold the concerned wings responsible for unreported leakages.

Recently, IIT Kanpur managed to bring down the energy consumption levels by 41% and water consumption levels by 70% from benchmarks set by the 'Green Rating for Integrated Habitat Assessment (GRIHA)' body. Here are the few steps taken on campus on a relatively large scale to achieve these inspiring results:

- Existing trees preserved and protected on site.
- 62% reduction in building water consumption by use of low-flow fixtures.
- 50% reduction in landscape water consumption by minimizing lawn area and planting native species of trees and shrubs.
- Only 17% paved area to promote water percolation and reduce heat island effect.
- Rain water harvesting system designed for reuse and recharge.
- Waste water treated and reused for landscape water requirement

Figures as per data obtained in April 2015

The details about the water supply network and consumption levels across different establishments in the institute were cited from a report published by Ms. Pooja Jain, a research coordinator in CTARA.

insight
the third eye

This article was originally produced as part of Issue 18 of the flagship print edition InsIght, IIT Bombay

A Setting Sun

TEJAS SHYAM

Image credit: Image is sourced from https://unsplash.com/

Brilliance flooded the darkness,
effulgence spread far and wide,
light letting loose its golden tress,
the mysterious hues lay untied.

In majestic glory untainted still,
with a vigour ere unseen,
as darkness slowly unleashed its will,
the light dulled in sheen.

Steadily as the hues did merge,
what wish but wish for it to last?
Slowly as the darkness surged,
the Sun had set at last.

A feeling undefinable,
a power so extreme,
and yet so calm – so stable,
the scene was like a dream.

Image credit: Image is sourced from https://unsplash.com/

The setting Sun in final zest,
spread cheer far and wide,
reminding all that life does have crests,
as it merged into the infinite tide…

Tejas Shyam
DUAL DEGREE, MEMS, '12

A teacher by choice and a poet by chance, Tejas is a passionate 'Edupreneur' who seeks to make learning an application-oriented process and inspire students to excel. His inquisitive mind seldom accepts anything without proof- English included! He has, in the past, worked as a freelance journalist with the Times Group.

If Rhodes Must Fall in Oxford, then Who Should in IITs?

PROF. ALIASGAR CONTRACTOR

Despite decades since the inglorious end of colonial rule, some of the icons of colonial Britain continue to stand tall in British academia. Recently, a group of students in Oxford belonging to former colonies organised protests to remove references in the curriculum extolling former colonisers such as Cecil Rhodes. Toppling of the statues of colonial figures in India was the low-hanging fruit that post-independent India claimed with glee as a mark of their independence. In the early days, the US-led invasion of Iraq post-9/11, was symbolised by the images of Saddam's larger than life statue being brought down with not a little help from American heavy equipment. But now one does not get to see that image often in the Western media since liberation has had unintended (though predictable) consequences. On the other hand, the IITs have been part of a silent revolution without the drama of toppling statues.

Reservation in admissions to academic institutions in India, including IITs are mandated by law and have been implemented with occasional outbursts of protests. But no political party that is a serious contender for power in the country or even in a state, has dared to publicly oppose this effort at affirmative action. In the early years, there was little public attention paid to this apparent violation of the holy cow of meritocracy, even if there were murmurs of anguish and much hand wringing in private. The Mandal provision of reservation for more caste groups did raise a public storm of sorts, but, without political patronage, it fizzled out. The recent episode in IIT Madras concerning banning of a students' forum (Ambedkar Periyar Study Circle) was perhaps a weak attempt to put people in their place by taking advantage of the touchiness of the present government to criticism. But when the MHRD refused to be drawn into the controversy, the institute quietly, and wisely, withdrew the ban.

The latest JEE results saw the national media high-lighting the performance of candidates from the so-called 'reserved category', who had fought the twin odds of poverty and disadvantage. It is not as if this is the first time that children from poor and disadvantaged backgrounds have made it to the merit list. But now we are ready to celebrate it as a triumph of talent over socio-economic handicap, not decry it as a dilution of merit. This is not to say that all is well. But we seem to be starting to confront the demons in our social structure. These are the demons that must fall in IITs.

For those of us who look at US universities as models of meritocracy, it would be enlightening to read an article by Ron Unz, the publisher of the American Conservative, in the December 2012 issue of the magazine. The article entitled, 'The Myth of American Meritocracy' looks at admissions to Ivy League colleges over the years. In the 1920s, faced with increasing number of Jewish appli-

Image credit: Frits Ahlefeldt www.landscapesofunderstanding.com/photo/34/All-rights-reserved-color-illustration.html

cants (escaping from anti-Semitism in Europe) with high academic performance, the Anglo-Saxon elite who controlled the Ivy League colleges, revised the admission policy to include non-academic criteria in evaluating an applicant. As a result, the number of Jewish students admitted to Harvard dropped from 30% of the class in 1925 to 15% in 1926. This number remained almost steady till the end of the Second World War, after which the Jewish lobby acquired clout and forced the colleges to dilute the non-academic criteria that worked against the new immigrants from Europe. In the 60s this was reversed to accommodate the demands for more representation for minority groups. In recent times, Asian-Americans find themselves in the same position as Jews of 1920s and 1930s. The average SAT score of Asian-Americans admitted to Ivy League colleges is 140 points higher than that of Whites, which is 310 points higher than that of Blacks. He concludes that the admission system is an arena for 'covert ethnic warfare'. We in India of course know that well. What he recommends as a replacement for this complex and biased system, should provide food for thought to JEE fans. The system he recommends is a mix of merit and chance!

Prof. Aliasgar Qutub Contractor

Prof. Aliasgar Qutub Contractor, former HoD of Chemistry Department, former editor of Technik, and former Dean Alumni and Corporate Relations, is an alumnus from C'73. Endowed with a rare gift of narrating serious and heavy matters with a tongue held firmly in cheek, his incisive and informed views on IIT Bombay and alumni relations are also in evidence in his column Sim Sim Khul Ja.

Where is my Chai?

SANJEEV SHANKAR

Spicy wild fruit vendor, Chandni Chowk girls school, Delhi. Re 1/- per pack

Street vendors constitute a motivated and sophisticated group with an informal and natural approach to their work, demonstrating a high degree of innovation and professionalism with a wonderful personal touch.

Steaming *Idlis* with hot *sambar* and spicy coconut chutney laid out on fresh banana leaves. South Indian filter coffee, popularly known as *kappi* placed in traditional stainless steel tumblers. Early morning office goers, attired in traditional whites awaiting their turn at a popular roadside cafe in Kerala. Seven hundred miles away, Bombayites, similarly have a wonderful range of delicacies to choose from as they return tired from work place. The riot of traditional recipes, which have no culinary parallel complete the spirited theatrical display of the Indian street vendor.

This article is a description of both Indian street food and the encounters with those magicians on the street – the vendors. At the same time, what began as a simple account has led me to reflect on the changing values and economic dichotomies found in Indian cities today: conceptions of public space and ownership; definitions of beauty and success; the urge for growth, cleanliness and efficiency. Investigating Indian street vendors and the food they sell came to highlight for me a paradigm shift in the pace of urban life; one that encompasses the clash of rich and poor, of

Vir Singh, Fountain, Bombay;Photograph by John Vijay Abraham

rural and urban, of literate and semi-literate, and ultimately, stories of stark survival on the streets. It became a rediscovery of the numerous layers that make up urban India, of the relationship between its cities and the countryside, and above all the food and culture of its people. It became an appreciation of the total sensory overload that is India, its musical honks, radiant smiles, screaming attires, labyrinthine streets, and overzealous strangers. This is a personal insight into a great nation and its brewing paradoxical realities.

The Magicians on the Street

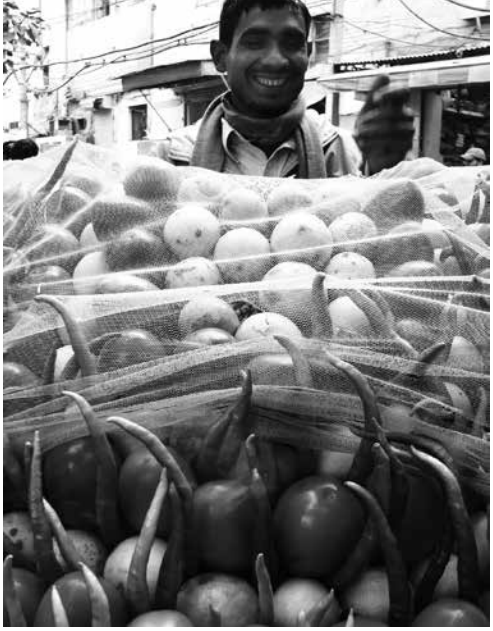
Vir Singh is 62 years old and has been selling dry fruits from the same spot in Fountain, Bombay for the last 42 years. He hails from Jaipur, Rajsthan. His day begins at seven in the morning at Kalyan and he reaches Victoria Terminus using the local train by nine. His wife joins him at four in the afternoon and they return home together at nine in the evening. He personifies the image of a larger than life figure: the wrinkled, weathered look; timeless, regionalised features and mature expression. He has been following the same routine for all these years along with his wife and eight kids who are also in the same profession. He is content but misses home.

Who are street vendors?

Street vendors are essentially self-employed people who earn their living by selling products and services on the streets. Their service is characterised by the absence of *fixed prices* and *brands*. Here nothing is *standardised*. Often hailing from rural India, they remain firmly rooted in their tradition and culture and help create a theater for the senses on the city roads. These vendors may be constantly on the move or they can be stationary, selling from a fixed place in a market or on the road side. The social and economic dynamism, which this informal sector creates within the wider system, is indispensable. A highly flexible, informal and evolved group, they generate a melting pot on the streets.

A typical street vendor could be a traditionally dressed lady selling vegetables on the street or a girl selling flowers in a local train. He could be giving a shave under a tree or offering juicy melons at a busy traffic junction. From a potter selling his wares on the highway to a small boy polishing shoes at a busy rail-

Spicy home made snack vendor, Girls school, south Delhi. Rs 2/- per packet



Spicy sprouted pulses vendor, Chandni Chowk, Delhi. Rs 5/- for one bowl

way station platform, he could be an entrepreneur with innovative solutions for repairing old electronic items or a palmist inspiring your business decisions. A street vendor could be any of these.

What makes them special?

Street vendors constitute a motivated and sophisticated group with an informal and natural approach to their work, demonstrating a high degree of innovation and professionalism with a wonderful personal touch. As such they encourage an atmosphere of easy human bonding through their spontaneity and genuineness.

Street vendors create their own employment and reduce poverty. They trigger economic growth, reflect the culture and tradition of rural India, and through this create a differentiated urban identity. Seen as representatives of social interaction as a whole in urban India, they symbolise an active link between the modern and traditional, the formal and informal, the public and private, and the trade and production realms. These interactions manifest in different ways: often fertile and meaningful, they occasionally turn confrontational. Street vendors are constantly used as scapegoats by city forces as sources of chaos, filth and pollution. Subjected to eviction threats, their legal status and very existence is being questioned by almost all the pressure groups within the city: the police, municipality, politician, real estate agent, private shop owners, vehicle owners and modern shopping mall developers.

Flavoured Juice Vendor, Powai market, Bombay. Rs 5/- for medium glass; Photograph by John Vijay Abraham

Can anyone imagine an Indian city without its vendors? From the sounds and smells to the colour, texture and vibrancy of animated expressions, they critically contribute to the heady experience of India. Unconditioned by formal perceptions of order and aesthetics,

Raj Kachori, Chandni Chowk, Delhi. Rs 10/- for one plate

they bring their unique sensory package into a city. By sustaining the common man and providing exceptional service at the doorstep, they are truly a city's lifeline.

The Magic on the Streets

- Boil 3 cups water
- Add 2 tsp tea leaves and 4 tsp sugar
- Add 2 crushed cardamoms and 2 cloves
- Add ½ inch slice of crushed fresh ginger
- Bring to a boil and add 1 cup milk
- Boil few times till we get the right fragrance and colour
- Strain and serve in earthen cups for four people

This would be an ingredient based lexical definition of masala chai. However, conveying the experience of enjoying a cup of hot masala chai in a cold Delhi winter with a group of strangers sitting crouched on the mud floor discussing politics, would bring back memories of the entire north Indian belt and the vibrant energy on its streets. How could those dark leaves of a diminutive shrub conjure up such imagination, fun, conversation, relief and magic in people's minds? This has been an important question for Sanjeev. The idea of Chai is greater than the image or sound of Chai. It is synonymous with goodness. It builds relationships and erases subtle biases beyond even colour, caste or creed. To witness a popular Chai joint is to see a democratic milieu of people from different sections of the society coming together to enjoy an informal and often open ended discussion. Further, with the price of a cup of Chai pegged at Rs 5/-, the service and product is affordable to anyone. Often, the extent of camaraderie is so infectious that the vendor willingly logs the tea in his account book or offers it on the house, the latter happening during festivals. I am often tempted to equate the dynamics of democracy in a nation to the number of Chai joints on the streets.

If it is chai, samosas and kachoris in north India, it is the irresistible vada pao, bhel puri and gol gappas in the western belt and the delightful idlis, vadas, dosas and uttapams in south India. We have always been delighted by the fertility of the minds that envisioned a samosa or pioneered a gol gappa! Indeed, street food is a great medium which helps every Indian reconnect with their past and with their childhood in a deeply holistic way. The

very mention of idli, conjures up images of something small, soft, humorous and delicate. Idli in fact finds mention in scriptures dating back to AD 920.

Such is the wonderful connect between the food of a place and its language that we can never imagine a samosa being called anything else or a dhokla being renamed. Translations are usually inadequate. The deep connect between food and its language has further resulted in a string of qualitative terms which bring in much needed dynamism and flexibility. Words like, garam and kadak are often directly associated with chai, and chat patta or khatta meetha with gol gappas and bhel puri. Indeed, the streets in India are constantly giving birth to new ligual terminologies in an effortless and often open ended manner.

Standing on the streets of New Delhi, Sanjeev is surrounded by desolation all around. Where is the splash of colour, the mix of attires and tinkle of myriad sounds? He, no longer sees people idyllically playing marbles by the bus stop or discussing politics next to the paan vendor. There are no chilled out cows, overzealous monkeys or curious dogs on the streets. Where is the balloon vendor outside the school? Where is the fresh lime juice vendor outside the bus stop? Where is his beloved Chaiwalla? They have all gone, in a single stroke: purged for creating discomfort and being detrimental to the pace of growth which we eagerly want and are getting accustomed to.

Today he witnessed a municipality truck with five officials in South Delhi, picking up vendor carts at random. They took away the utensils and the stock. Other officials decided to use their sticks to beat up vendors and break their eggs. There was milk all around. They finally drove away with apparent glee. Sanjeev had been acquainted for several weeks with one of the vendors they attacked. Many say that Delhi is only going to be for the rich from now on. His barber shares, how, everyone wants to rid Delhi of its ills and make it like Europe. Others say this with a sense of pride: this is progress, they say: "we will soon be like the West". They all say this – politicians, transport authorities, municipal bodies, and the police.

This is not a nightmare. If all goes as

Fresh Mix juice, South Delhi. Rs 10/- for medium sized glass

planned by the authorities, Indian cities will soon be as sterile and desolate as they are in the West, and our obsession with cleansing, our persistence to rid the system of its variables, will be at the core of this. Since when did India become so intolerant? Since when did we learn to become so efficient, that we began wiping out the very essence which makes us unique? Since when did India so acutely want to run at a pace which is detrimental to its own diversity and sustenance?

Can't we be more accommodating? Is purging our only solution? Are the convictions of the educated middle and upper middle class, right? Shouldn't a diverse nation like ours look for more holistic solutions? Surely, Delhi is by no means representative of India, but it certainly drives national opinion along with other major cities like Mumbai, Calcutta, Chennai, and recently Bangalore, Pune, Hyderabad and Chandigarh.

In view of this, the more time Sanjeev spends with street vendors, the more he begins to feel a sense of empathy towards them. In the last three years, his excitement for street food in Delhi, Mumbai, and Goa has given way to much introspection, a growing discomfort and shock at the high-handedness of authorities in India. Much like mute witnesses, the vendors carry on. They keep coming back. The day this stops happening, our cities will indeed become comparable to any other city in the world. They will share the same sense of boredom and clinical efficiency which

one associates with modern cities. They would be divorced from the flavors which really mean India. They would become reservoirs for the chosen few who would take pride in its linearity and predictability. By showing our explicit love for the fast food industry where everything from pizza delivery time to the- height of the pizza after baking- is standardised, we are creating a platform for a monoculture. While the West seems to fail in its quest for diversity and fertility within its cities, our authorities are convinced that, the western model is our only answer for the future!

Salute!

Meanwhile, our vendor is back the next morning. Sanjeev is impressed and inquires how many times this has happened, and he replies with defiance, “three times in the last two months”. Sanjeev asks again,“Don’t you pay money to the cops and the authorities?”. He answers, “of course, we even pay in kind, but there is still no guarantee”. The cart is from his friend, a fresh juice vendor. The fresh juice business is not very popular in winters. We are informed that the municipality truck picked up 12 carts yesterday. There are no eggs today since all were broken in the clash. However, the vendor remarks, “eggs will arrive soon.” Meanwhile he lights a fire with the waste paper lying around to warm up the place. This attracts students, construction workers, security guards, house maids and soon the greetings give way to informal exchanges. People start enjoying their early morning masala chai. Meanwhile, a brilliantly dressed doctor comes from the hospital behind and orders the vendor to bring 10 cups of hot tea and three omelettes into the conference room. The vendor starts working on it immediately and later gives Sanjeev the honor of making an omelet.

Indeed, there is a wonderful method on these streets, a system in place and a deep sense of balance. Street Vendors live in the present and thrive amidst contradictions and complexities. We, the people, love them and value them. They are an integral part of India and personify its spirit and values. Sanjeev silently thanks every street vendor along this journey and looks forward to another glorious, colourful and fragrant day. ♦

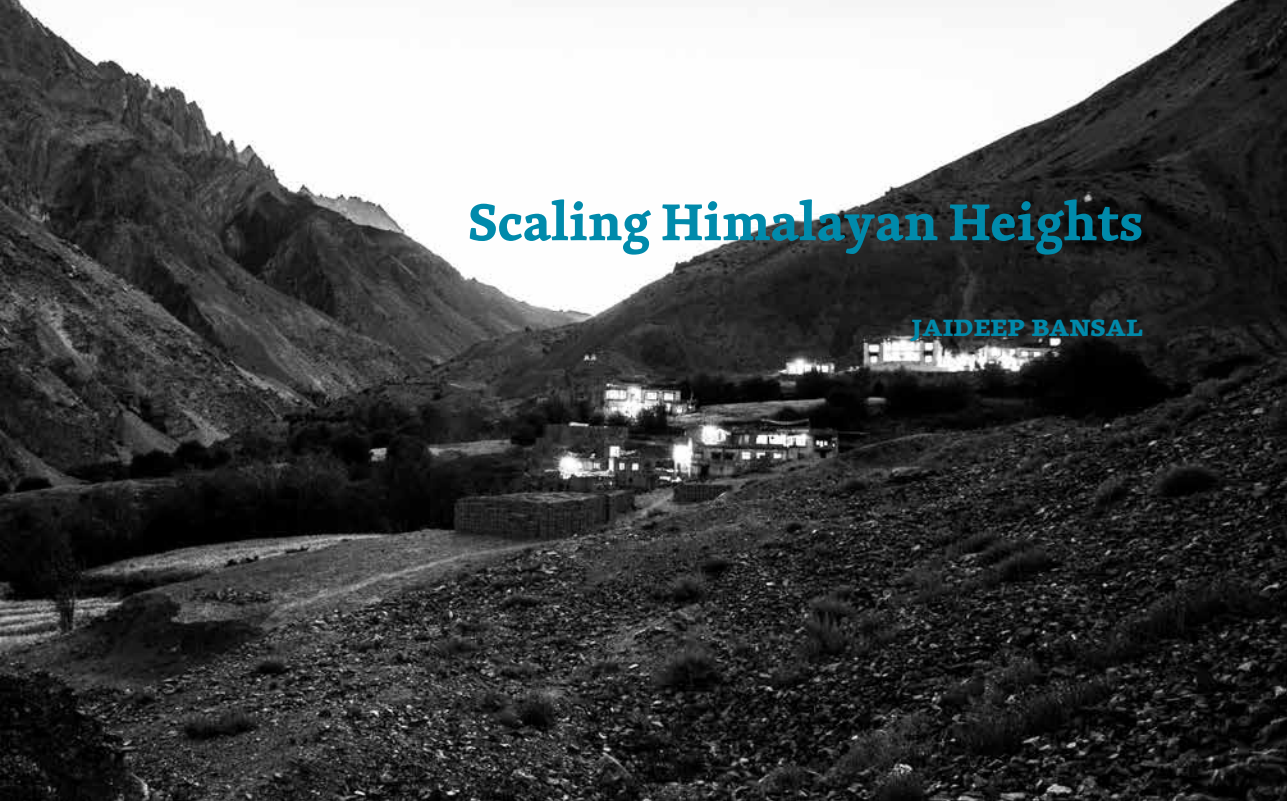
Sanjeev Shankar
M. DES. IDC , '04,

Sanjeev Shankar was born in the Nilgiri hills of Southern-India. As founder of a trans-disciplinary creative studio, Sanjeev uses his training in design, science and architecture to merge traditional crafts-based knowledge with contemporary cultural and technological patterns to develop socially responsible and life enhancing solutions. Over the last decade, he has inspired and galvanized communities globally by walking the thin, exciting line between restraint and risk. He was shortlisted for the Emerging Architecture award at the Royal Institute of British Architects in London and has won the "10 Great Ideas to change the world" project, a global initiative focussed on revitalizing the planet by the Indian Institute of Technology Bombay. The article published here was inspired by Sanjeev's 2005 project at IIT Bombay Industrial Design Centre and written in 2007-08 for FoAM (http://fo.am/people/sanjeev.shankar). Sanjeev blogs at http://www.sanjeevshankar.com/.

The Art of Giving

Here we bring you a selection of three pieces that are woven around the joys (and travails) of giving, whether in cash or kind. Tailgate Jaideep as he climbs the snow-clad peaks of the Himalayas in a single-minded endeavour to bring light to remote villages in Ladakh. Or, read Ashima's heart-warming story about volunteering at a children's centre in Luanda. In a different vein, join Dr. Behruz N. Sethna as he raises a contentious point about fundraising: should one who has the gold make the rules?

Humblebee



Scaling Himalayan Heights

JAIDEEP BANSAL

When I joined P&G after graduating from IIT, the first two years of job life just went by doing nothing but office work. The day began with office and ended with office. I realised that I wasn't really adding any value to myself beyond office work. That's when I met some brilliant individuals like Sir Robert Swan (first person to walk to the North and South Poles), the Cycle for Water team (these guys took a sabbatical from KPMG and cycled for 2 years from the North Pole to the South Pole to raise awareness for drinking water) and Paras, perhaps the first person I met to go to Antarctica and who left his job to start the Global Himalayan Expedition (it is the first of its kind social impact initiative in India, which combines development initiatives including setup of sustainable infrastructures with a focus on providing clean energy, education and leadership, while leveraging adventure tourism as means to create positive social impact communities).

I am an adventure seeker, and my love for mountains made me get involved with Paras on the Global Himalayan Expedition as a team leader. Our team has two things in common– a love for the snow-clad peaks of the Himalayas and a desire to give back to communities in the remotest parts of India. These communities do not have access to basic needs such as electricity and education. What makes it difficult is the geographic disconnect of these communities from the rest of the world.

So in August 2013, we started our intervention on the education field and established the Third Pole Education Base (E-Base) in Leh, Ladakh at 12,000ft. It is a 100% solar-powered digital education facility, made up of sustainable building materials such as rock, clay, paper and husk, and hosts a mini library, tablets, internet andvarious other experiential learning tools.

I am very happy to see that now 500 students of Leh are using the E-Base as part of their curriculum, focusing on sustainable solutions around clean energy, waste management, water conservation, bio-diversity and local Ladakhi culture & traditions. We have a very strong Third Pole Fellowship program

where we get a Fellow for 3 months located at the E-Base, working on developing a standard curriculum. The E-Base is also being used to facilitate cross-geographic learning by exchanging ideas on climate change with Ashley School, UK (winner of 2009 Ashden Sustainability Award). As part of our interventions, we did a career counselling workshop for all students to provide them direction on career options to explore.

We have also setup the first ever robotics lab and a solar lab in Leh, to further enhance the learning of the students. The idea is to provide education very specific to the needs of the local community. These students come from remote villages without electricity, so they can come to the E-Base and learn in the solar lab, how to practically convert sunlight into electricity. This knowledge would empower the students to build their own solar grids one day and bring their villages out of darkness. The possibilities are endless.

Carrying forward the focus of our interventions, in August 2014 we went a step further having set our eyes on the electrification of a remote village located at 14,000ft in Zanskar Valley (Ladakh). Sumda Chenmo, a 1000 year old village, never had access to electricity. The village households have been surviving on kerosene fuel for decades to fulfil their lighting and energy needs.

We trekked for 3 days carrying solar panels, batteries and wire bundles to reach the village. On the way to the village, we scaled the Himalayas—crossing over passes at 16,000 feet, narrow trails, and river streams. At night, we slept in the wilderness under the Milky Way; it was a magical experience.

Upon reaching the village, the team wired up all the houses in the village, dug holes in the ground to plant electric poles, fixed 121 LED bulbs, a DC LED TV and installed 3 sets of 320W Solar DC micro-grids. We setup the grid in a single day, illuminating an ancient heritage with the latest in technology. This was the first suchinstallation by a group in the Himalayas and the first for the villagers to witness electricity, which they have been devoid of

since decades.

Something so basic to us – you enter a room, you flick on a switch, and the light comes on–had never been experienced by these villagers. Their spontaneous joy and dance made for a truly magical moment. The villagers started dancing and singing Ladakhi songs and had tears of happiness in their eyes. That night we slept with the lights on; the villagers just refused to switch off the lights.

This April, when we went back to the village of Sumda Chenmo, we could see the benefits of the work our team had done: For instance,

- An increase in income generation through home stay (with participation of 80% households) of ₹ 200,000 per annum for all the 10 households of the village
- Reduction in CO2 emissions from 1600 litres of kerosene
- Eliminating almost 4000 kg of CO_2 emissions from the village
- Extending the work hours for village artisans by 4hours/day by using electricity post dusk
- Updates through DC LED television provided at village community centre
- Improved weaver and artisan community
- Increase in home stay promoted by clean and hygienic houses in the village

I have taken a sabbatical for 3 months from P&G and we are electrifying 10 villages in the Ladakh region and 2 in Nepal that were affected by the earthquake. As I write this, we have electrified one remote village in Ladakh, and the villagers could not believe what they saw. It was a very heart-touching moment when we switched on the light. They covered the batteries in yak wool, like they do for their kids, and put a khatak (traditional cloth used to greet people) on the switchboard.

There is a Tibetan saying that goes something like this: the highest art is the art of living an ordinary life in an extraordinary manner. Living in a world of luxuries, our key takeaway was to move a step closer to self-realisation, learning from the remote communities who manage to stay happy even without the basic amenities.

For me, the tears of happiness on the face of the oldest villager when she saw her house lit up in the darkness for the first time in her life was a moment that continues to inspire me to put in all the extra effort.

Jaideep Bansal
B. TECH, MECH E, '10

Jaideep Bansal is an IIT Bombay graduate of 2010 working with Procter and Gamble and the Curator of the Global Shapers Chandigarh Hub. When not streamlining operations at P&G, he is found composing music or running marathons/cycling expeditions. He is amongst the top 200 Marathon runnersof India.
He is the team leader of the Global Himalayan Expedition, and is involved in electrification of remote Himalayan villages using DC Solar Micro-grids. As program coordinator for the Third Pole Education Base (Leh), he works on running the fellowship program at the E-Base and developing the curriculum along with the E-Base team.

Volunteering in Luanda: The Highs and the Lows

ASHIMA GOYAL SIRAJ

Today, it's exactly 18 months since I first landed in Luanda. It's almost like yesterday. How excited and anxious I was! This was the first time that I was moving to a country of which I had no clue. In my "we shall cross the bridge when it comes" attitude, I hadn't even read much about living in Angola or what I could do in Angola. I was just excited to be in Africa.

It took about a month to get a place and get a basic set-up going in terms of a home. After that, whoever I met, I asked if they knew some place I could volunteer in. I knew that if I wanted to call Angola home (even if it was just for 3 years), I would have to go out and be a part of it. It was easy to get comfortable in the warm and welcoming expat circles, which I am grateful for, but working with children is what I love and I had to find a way.

In the following February, I started volunteering with a local non-profit- 'Fundacao arte e cultura'. They have a lot of projects, but I primarily volunteer in the children's centre. I love spending time with the kids, designing and taking new sessions and just being there for them. The last 16 months have been beautiful, with their fair share of ups and downs. This has been my longest, continuous, full-time volunteering project till date. There is so much that I have learnt, particularly while volunteering in Luanda.

Language was the first thing that I was hesitant about, before coming to Angola. I knew just about five basic phrases when I started volunteering with children. It's amazing how much one can converse simply by gestures and body language. But more than that it was amazing how quick I was able to learn the language with them. They were not shy of laughing at me when I spoke something that was grammatically incorrect. Moreover, they weren't shy of correcting me. Most adults would try and understand what I was trying to say and didn't feel the need to correct. Thank God children are not spoiled by our false sense of etiquettes!

I followed my husband to Angola. As soon as we reached, we immediately had a circle of engineers (and their families) working in the same field. Angola is portrayed as a very unsafe place and so avenues of meeting people outside of his field were limited. But when I started volunteering, I saw a whole new side of Luanda and Angola. I came across so many creative people - artists, musicians, writers and dancers. With them, I explored the city and its culture. Volunteering helped me be more me than just an expat wife. With them, I found inspiration to create something myself.

I met local heroes in small communities outside the city who were running schools in their backyards. I also met musicians teaching music to children on the streets. And I found new purpose for my skills.

Volunteering allows for a lot of freedom. It allowed me to work on my schedule and do activities that I liked. However, more than that, I knew that I had an avenue in the organization that I was volunteering with to try different ideas. When I arrived, the children's centre did really have a lot going on. Therefore, I was told that I have all the freedom to bring new sessions. But with freedom also came the responsibility of the children. I loved that responsibility. It motivated me to try harder, to not give up if one way of teaching didn't work. And to see the children slowly blossoming has been the biggest reward.

Image credit: Image is sourced from www.unsplash.com/

Teaching is a two-way street! And I am not just talking of the children teaching me the language.

In order to teach them, I would look up newer activities and practice and learn before teaching them. The one thing that really concerned me was the lack of recycling and, instead of complaining about it, I decided to do more recycling activities with the children. My strongest belief is that if a message has to go out into the society, the children of the society have to be the ones taking it there. If they understand that things that seem like an apparent waste can be turned into beautiful objects, they are less likely to throw it into the garbage or let their elders do so. I never thought I would ever know how to weave a basket with newspapers or how to create a wall mosaic with toilet paper rolls. We are all learning together here.

On the outside, Luanda currently looks like a picture of development. There are the latest models of everything and high rises are coming up everywhere in the town. But the country went through a civil war that lasted thirty years and that ended just twelve years ago. Thirty years is more than one generation. A very small section of higher middle class and upper class Angolans were able to escape at that time and come back later to claim all the big jobs. Because of my volunteering, I work with and meet people who witnessed and lived the war. I met a girl who was taken in as a slave when she was a child and it was only after eight years that she could escape. I met another who lived in a forest for almost a year when her family fled the war. I feel that I got a better sense of the societal fabric because of a better understanding of where it came from. And that gave me a sense of belonging.

But it is not all rosy. There are days when I suffer from bouts of helplessness, frustration and losing hope…When I started building a database of all the children who came to the center, I saw that, in a month, more than a hundred different children came to the center,

Image credit: Image is sourced from www.unsplash.com/

but not one of them came regularly. A child who came today, may come the day after, the week after, the month after; or may not come at all. I try to understand, but still, at times, it is difficult to accept that a ten year old has to stay back at home because she/he needs to cook food for the family; or because her mom has gone for work and she has to look after the baby or it because it rained so hard the day before that they have to spend the entire day removing water from their home, one bucket after another.

Sometimes there are kids that have been abandoned by their families. A priest who runs an orphanage of abandoned children told me how the children go through a completely different trauma because they know they have their parents and still can't see them or be with them.

Sometimes they do an artwork that leaves you bewildered. One child painted a high heel sandal stamping on a heart, with blood coming out of the heart, and a crying rose. What was it all about? She never came back and we could not find her home!

Volunteering has been a mixed bag of emotions for me. I have experienced happiness, love, pride, joy, disappointment, fear, hope, faith and freedom. And it is these experiences that have helped me to integrate myself into the everyday life of Angola. It is these experiences that help me be more me. Everyday that I volunteer, every day that I go out and serve, I learn something new about the city and its soul. And I feel like I am no outsider.

Ashima Goyal Siraj
B.TECH. ELEC. E, '03

Ashima started volunteering when she was just seven, helping her father during a medicalcamp in a disaster stuck region. Service and volunteering are a way of life for her. She has volunteered in five countries and across different causes. She shares volunteering experiences and resources to promote volunteering at www.VolunteerWeekly.org — a gift blog entirely run by volunteers.

The Golden Rule, Balgram, Michelangelo, IIT, and IIM

BEHRUZ N. SETHNA

Only partly tongue-in-cheek, in fund raising circles, there is something called the "Golden Rule" of fund raising which goes something like this: "He (or she) who has the gold makes the rules!'

What that means is you should be available to go to the location they want, present the proposal in the form they want, and make the pitch for things that interest them." [1]

As background, I need to say that I lived by this so-called rule for almost a quarter of a century in a fundraising role in higher education, raising tens of millions of dollars (hundreds, if you include state moneys for buildings), as Dean and as President in American Universities.

Yet, the major part of this article is devoted to the *limitations* of this "Golden Rule" and what it should not *mean*.

Let me start with a little personal story. Bear with me; this is leading somewhere.

Each summer, I teach at *Balgram*, an orphanage school near Lonavala. It is challenging and extremely rewarding. I have also, over the years, provided ongoing "sponsorship" support for one child, then two, then four, and now eight children in the school. It is my honor to do so, and I seek no compliments for this; credit if any, goes to my parents and my aunts who left me some money which I want to use in this way. When I started sponsoring a child, I was asked if I have preferences as to gender or religion, or any other demographic variable, and I emphatically said "No." I told them that they know the situation best and that they should make the decision. They did so, and chose a delightful girl, whose name I will not reveal so as to respect her privacy. Sufficeth to say that she has ambitions of being an English teacher and, several years after that decision, to this date I encourage her to follow her dreams, and will help her further if she needs help. I followed the same policy of letting the very capable administrators make the decisions for the other seven children. After all, the fact that I have some money to share does not magically invest in me the knowledge base and expertise as to the running of orphanages or the selection of children who need help. That is not my field; I have not spent one day of my life doing that job, and so I must trust those who have done this for many years.

Separately, having been a Rotarian for the past thirty-two odd years, I am trying to get a Rotary International grant to help Balgram. And, again, the approach is the same. First, I spoke with the orphanage administrators to find out what their most pressing needs were. My Rotary Club and a neighboring one are prepared to put up a few thousand dollars each, and now I am trying to figure out how we can write the grant proposal such that we

1 Excerpted from "Who Wants To Be A College President?" B>Quest, 2015, by Beheruz Nariman Sethna, http://www.westga.edu/~bquest/2015/president2015.pdf

Image credit: Frits Ahlefeldt: www.landscapesofunderstanding.com/photo/12/Divine-inspiration-color-illustration.html

can have the best overlap between *Balgram's* needs and Rotary International's criteria. I have no idea whether we will be successful or not, but we will try. But, the point I am making is that the first step was finding out what Balgram's needs were. The possession of funds or the membership in Rotary does not magically invest in me the knowledge base and expertise as to the enhancement of an orphanage. That is not my field; I have not spent one day of my life doing that job, and so I must trust those who have done this all their lives.

Now let me go from Lonavala, India of 2015, to "long, long ago in a land far, far away"[2] and go back approximately 450 years in time to Italy, and talk of Michelangelo, considered by many to be one of the greatest artists of all time. Artists, in those days, were supported by patrons, and Michelangelo had two primary patrons: Pope Julius II, and the Medici family. Think, for a moment, how the great works of Michelangelo would have turned out if, by virtue of their financial support, either the Pope or the Medici family would have had decision power over the Pietà and David, two of the most awesome and awe-inspiring sculptures of the Western world, or the scenes from Genesis on the ceiling of the Sistine Chapel in Rome or The Last Judgment on the altar wall, two of the most awesome and awe-inspiring paintings/frescos of the Western world. Can you visualize the Medici family deciding the form of the limbs, the positions, the muscular structure of the sculptures, or the Pope insisting on his design for the art work or the colors used in the Sistine Chapel paintings? Again, the moral is the same: The possession of funds did not magically invest in either the Pope or the Medici family the knowledge base and expertise or abilities as to the enhancement of sculptures or paintings. Had they thought it did, it would have been a disaster!

Now, having built this case, let me come

2 Modified/adapted from the opening "crawl" in the original Star Wars film, 1977.

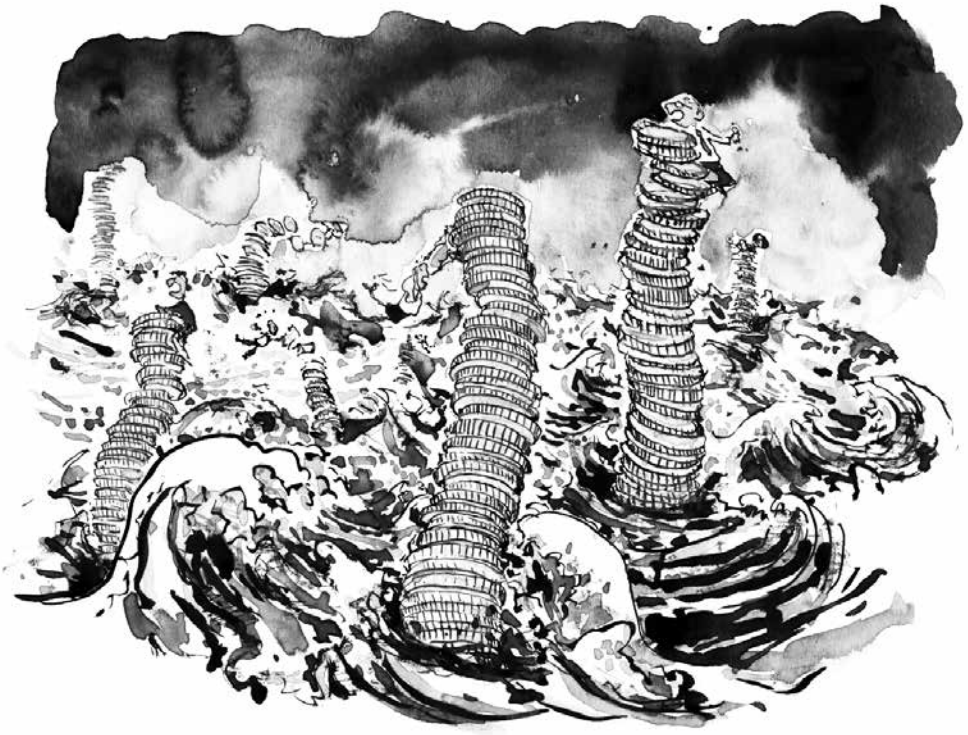


Image credit: Frits Ahlefeldt www.landscapesofunderstanding.com/photo/420/Climate-Change,-Money-stacks-in-flooding-Color-illustration.html

to the main point of this column (*"finally,"* I hear you saying): The government has decided to exercise tight controls over the IIMs, as it already does so for the IITs, though – who knows – more may come. I am respectfully, but strongly, opposed to these. It matters not if these are controls over the IITs or the IIMs, or whether they are old or new ones; to my mind the response is the same: Let the professionals do it. As I said of myself and the orphanage, "That is not my field, I have not spent one day of my life doing that job, and so I must trust those who have done this all their lives."

In June of this year, I published a column in *The Hindu* on this topic [3], and here I excerpt only a few paragraphs:

"Change is most dangerous when it is brought forth not because it is necessary but because someone simply has the power to initiate it and wishes to exercise this power. This seems to be the reason for the Human Resource Development Ministry's proposal for an Indian Institutes of Management Bill, 2015.

It is important to note that world-class institutions are not built based on the decisions of politicians, but by those within the institution — those who spend a lifetime in their respective fields and make important decisions concerning the functioning of the institution. This is especially because political parties and agendas come and go, and therefore their temporary presence should never be allowed to influence academic decisions and excellence.

The IIM Bill, in its present form, intends

3 "Let IIMs be free of government stranglehold" by Beheruz Nariman Sethna, www.thehindu.com/opinion/op-ed/let-iims-be-free-of-government-stranglehold/article7354672.ece

to take away that decision-making power from the hands of the very people who created these great institutions through decades of hard work. …

The question to be asked is: Is the government really interested in supporting and enhancing world-class institutions or does it want to engage in one more bureaucratic exercise? For the sake of India and its students, for the sake of corporate India, and for the sake of jobs and academic excellence, I plead with the government to abandon these initiatives."

I make the same argument for the IITs-particularly IITBombay, which has a truly global brand. The IITs too need to be free of government stranglehold.

No party in power (in India or the US or anywhere else) wants to accept that their "rule" will not last forever. But no rule does, and they should be careful what they wish for! It is a reality of life that no single party lasts forever, and no single party philosophy lasts forever. Let us consider a hypothetical government, under another political party which – just for the sake of argument, believes that a different economic or developmental policy is best for India. They may issue a policy directive that their philosophy is the only road to go on, and thereby no teaching or research espousing any other topic would be allowed! Government policy directives should never be allowed to trump academic freedom and intellectual thought.

Certainly, neither the IITs nor the IIMs are perfect; all of us can improve ourselves. And certainly, the relevant stakeholders including alumni, business and industry, employers, citizens, and yes, the government, should give their *inputs*. But, the professionals should be the *decision makers*. Professionals and students/alumni built the brand and these wonderful institutions, not government bureaucrats. Their control of funding does not magically invest in them the knowledge base and expertise as to the enhancement of these institutions, any more than my having funds to share magically invests in me the knowledge base and expertise as to the enhancement of *Balgram*, or the Medici family and the Pope financially supporting Michelangelo magically invested in them the knowledge base and expertise as to the enhancement of some of the greatest works of art of all time.

If government insists on implementing its stranglehold, it would be the equivalent of an amateur's scribblings on the Sistine Chapel, lasting for hundreds of years, for all the world to see, and wonder:

"*What were* those people thinking?"

Dr. Beheruz N. Sethna
B. TECH. ELEC. E, '71

Dr. Beheruz N. Sethna is a professor of business and retired sixth President of the University of West Georgia (UWG). A distinguished alum from both IITB and IIMA, he is the first known person of Indian origin ever to become president of a university anywhere in America. He also obtained the University's first endowed Chair. Beheruz has published a book and 69 papers (30 since becoming UWG President), several case studies, and obtained externally funded research from the U.S. Department of Energy, IBM, AT&T and others. Amongst his many awards, he has been named among the 100 most influential Georgians. He has also recently been awarded Founder's Award the highest honor from the University of West Georgia.

Yesterday is Another World

ANU MOULEE

The month I turned twenty, I packed my bags to move to IIT to begin my Masters. At the main gate, a pleasant young man offered to carry my bags as the hostel was "some distance away". No man was going to carry the suitcase of a young feminist, so I declined the offer. "Suit yourself" he said cheerfully, and walked on. So began my IIT residence, which lasted a couple of years longer than I had intended it to.

The hostel was indeed some distance away and it turned out to be a low structure shrouded in green cover. I was allotted a room in one of the fresher wings and found myself in a little room furnished with a cot, a mattress and a study table. But at that moment I sat on my bed and, despite being the product of a very liberal home, savoured the beginning of my absolute freedom.

In view of the low number of undergraduate girls – a situation that has changed now I gather – Hostel Ten tended to have a greater mix of undergraduates and postgraduates than any other hostel. The boundaries between the two were therefore far more blurred than in the boys hostels though, it is said that sometimes, a 16 year old and a 21 year old inhabit entirely different worlds. Most postgraduates arrived as young women; the undergraduates were young girls who would go on to be vastly shaped by their four year residence.

In the first year, at least, your wing was likely to have a sizeable number of undergraduates; this was the case for me too. The bunch in my wing was a boisterous lot and struck up instant friendships. The problems they faced were entirely different from ours and it was instructive to watch their struggle with large classes, grades and boys. Nothing too different from the concerns of an average adolescent girl, except that more than a few were far from home and everything they had known. Some revelled in this life, others moped. The locals disappeared on the weekend and returned with food and washed laundry.

"Some revelled in this life, others moped. The locals disappeared on the weekend and returned with food and washed laundry."

Speaking of laundry, three of the undergraduate girls in my wing stationed a bucket of clothes in the wing and took turns in picking a daily "outfit" from it until someone took pity on them and engaged a woman to wash and press their clothes. And, speaking of food, nothing was looked forward to more than the return of a girl. A few of my friends had exceptionally kind mothers who kept us supplied with delicacies all through our student life. The appetites of young women are ravenous.

The Hostel Ten mess had a bit of a reputation for being one of the better messes

Anu in the wing of hotel 10

(read 'food was edible'). If you made a male friend, his acceptance as a H10 man could only be sealed by having a meal at the Hostel. The meals themselves were run of the mill and interrupted by a special day of "Chinese" and ice cream as well as a Sunday lunch. But, more than the meals, it was the akshaypatra of strong, hot tea that facilitated idleness, friendships and romances. The steel cups, with a void space that were ubiquitous in middle class India of the 80s, shone in regular lines and they and the tea were replenished regularly. In the matter of tea, the femme-formidables who managed the kitchen were generous. If we arrived late, they were always happy to brew up a bit more.

I managed the Mess for a year and there are few jobs more thankless than it. The nexus of the mess management and staff is hard to break. The ladies who ran the kitchen had been there for a long time and a small girl passing through officiously for a year was hardly likely to deter them. In the interests of transparency, we also decided to make the breakdown of the mess bills public which led to an EGBM with an epic showdown- I can still picture the Warden looking faintly bemused by the proceedings. Much later, when I found that a mess co-ordinator of a boys hostel had bought a motorcycle by his judicious management of mess and canteen, I thought, "Well I might as well stick Ms. Stupid on my forehead at this point ". Joke! But the most rewarding outcome of that year was knowing the mess staff. A number of them had been there for years and came from tough backgrounds. I found it hard to grudge them their obduracy, their surliness and their pilfering. Some of the younger ones were lovely; despite the nature of their chores they maintained good cheer and now and then got us tiny eats from home. Illness claimed them at a young age, and I still feel a little sorrow when I look at their children. On the plus side, the Hostel

Friends taking a swing on the gates of H10

Ten canteen was started by us and watching its progress gave us a lot of happiness.

Apart from the Mess and the simple rubbing together of daily life, the number of activities in the Institute brought together both the UG and PG girls. Hostel Ten was always a bit coveted for the PAFs – though this did not always mean that they took first prize. For a month or so the hostel would see feverish activity - and a boy influx – until we would see the girls on stage, mostly lovely and talented. The more intimate Valedictory Function tended to be a bit of a riot given that it was mostly in-house and a send-off. I can't set down the exact specifics, but let's just say that I both laughed and cried really hard. In the summers, there would be few of us around and this bound us together even more. The heat, the late spring flowers and long night walks -these were what made my most intimate friendships.

One thing that absolutely divided the UG and PG populations even in Hostel Ten was academics. First up, there was the mystique of the B.Tech degree from IIT, a holy grail for the Indian middle class child. Secondly, few women were encouraged to pursue Engineering; fewer still made it to IIT's portals. The postgraduates, on the other hand, were in courses that did not have skewed gender ratios. An MSc Chemistry class, for example, had a number of girl students. Whether this made any difference- that is not for me to say. But B Tech classes are an exceptional situation.

To me, at the time, IIT was an unusual situation. It wasn't unpleasant; indeed more than a few close male friends are from my years there. Yet, going to meet my brother at his hostel or a friend at his would bring about a certain consciousness if you will. Sometimes, events like a Pagal Gymkhana on which we penned a fiery piece which provoked much comment or the response to the bolder girls in the Hostel were evidence that an overwhelm-

ingly male population produces a certain culture. I do not mean to say that this is any way inimical or threatening. In fact, the mix of chivalry and nonchalance of the first boy I met in IIT is fairly typical of the boys of the Institute (Note: I never met him again). But the feeling of being very few in the midst of many marks the IIT experience and sets it apart from other educational institutions.

But within the Hostel one was insulated from all this. Staying in a hostel results in life-

"Hostel Ten was always a bit coveted for the PAFs – though this did not always mean that they took first prize. For a month or so the hostel would see feverish activity - and a boy influx – until we would see the girls on stage, mostly lovely and talented."

long bonds. Sneaking in a beer and indulging in dirty talk at 2 am in the Hostel wing can do that. As can a whole load of silliness and hilarity over small matters. Or weeping over spoilt exams and spoilt romances! Or running up a bonfire and making tea at 2 am – really a LOT happened at 2 am. Or being forced to stick to a study schedule by your more studious counterparts. Or residing in a wing luxuriant with ferns and the earth mother warmth of the older PhD students. Even the sorrow of having one of your own taking her life- all of this marked my years in Hostel ten.

I spent a very long time in IIT Bombay and it took me awhile to come back once I left. But never once did I feel the same way about the Hostel. It remained my happy place, and I feel a curious sense of loss to think of it torn down-as if age had overtaken me and a new world had shaped itself before I knew the old had passed.

In the old courtyard of Hostel Ten, tulsi grew wild like a weed. My grandmother, whose tulsi struggled in a little pot, would look at it wistfully and say perhaps it grows so much because Saraswati resides here in all these girls. And it is true that IIT is primarily a place of academics. But that wild, bold growth was also me and many others I knew. I entered IIT as a sheltered and pampered girl vaguely desirous of freedom; I left it as a grown person who had found her own voice. This, I owe to the Institute! But even more so, I owe the woman I am to Hostel Ten. And to the girls I met there and who are still an integral part of my life. ♦

Anu Moulee
M.SC. CHEMISTRY, '87

Anu is an ex-IITian (MSc in 1987 and PHD PhD in 1993) who earned her journalistic stripes by writing a controversial article on Pagal Gymkhana antics in one of IIT Bombay's cyclostyled rags of 1985 and subsequently editing Pragati. Despite this - or perhaps because of it - she did not pursue writing, choosing instead to do what all good middle class girls do. A PhD in Polymer Chemistry and a corporate job with Unilever followed. Somewhere in between she qualified as a patent attorney and then promptly decamped to Sydney, Australia for the sun and surf. When the days were cold and rainy - and there were a lot of such days - she worked for a patent firm. She took a career break at the end of 2013 to travel and spend time with family. Of late she has been working on freelance projects. She also runs a blog on the history of Indian clothing - a bit of a labour of love - which can be found on tumblr . (http://vintageindianclothing.tumblr.com/). If she ever had to wear a T-shirt, it would have the slogan "H10 Forever!".

The Convocation

ARNAPURNA RATH

Image credit: Image is sourced from https://unsplash.com/"

The day I graduated,
I blew a kiss at my mother
from the far end of a velvet red podium,
full of stiff-necked,
scholarly eyes,
squinting down,
at the earthlings,
dressed in their convocation fineries.
Draped in white,
starched, smelling like the
linen of hospitals and asylums,
I,
tasted the blood-sweet smell of victory.
Chuckling to myself,
that I will be the Ulysses of my time
and someday seek
and achieve glories.

They crowned me.
They celebrated me.
Sang hymns in my praise.

Soothsayers prophesied the 'arrival',
Astrologers said that this was the 'second coming'.
No one told me
in this clamour of celebrations,
that I was
trying to catch a rainbow.

Arnapurna Rath
PH. D, HSS, '10

A new bee of the bee-town, Tinker-bee loves tinkering around with forms of writing and is in quest for new genres of creativity. An alumni of the batch of 2010 IIT Bombay (Department of Humanities and Social Sciences), the Tinker-bee researched on the theories of Mikhail Bakhtin and the fiction of Amitav Ghosh for her doctoral degree. She is currently working as Assistant Professor in Humanities at IIT Gandhinagar. The Tinker-bee has a passion to explore intersections between literature and philosophy, between theory and practice, and between life and creativity. She believes that a little compassion and some poetry in life can make the world a better place to live.

Debate on Location of Karnataka's Proposed IIT

ALI KHWAJA

Image credit: Image is sourced from www.unsplash.com

It's been over forty years since I graduated B.Tech. (Met) from IIT Bombay in 1974. I still remember cycling on the old rickety hand-me-down cycle from H7 to the cycle stand near Y-Point, locking the bike (as though anyone would like to steal it) and then coming out to wait for the ever-elusive bus to Vikhroli station.

IIT was located in the second biggest metropolis and the commercial capital of our country, but in our campus we may as well have been in Timbuktu considering the facilities, connectivity, and interaction with the city. We had a pay-phone in our hostel which would at best work for about ten days in the month, and those ten days there was a queue to make the rare call with a one rupee coin. And that also was the privilege of the selected few who had family or friend in Bombay, as outstation calls were not possible.

Yet IIT Bombay produced innumerable super-achievers who went on to win laurels, contribute in many ways to the world, country and society. They often overtook their counterparts from the prestigious Harvard, Stanford and MIT (Massachusetts, not Manipal) and made inroads into fields as diverse as administration, banking, marketing, HR, etc., and of course some in technology too.

I do not recollect very many classmates being from Mumbai, or even from the entire Maharashtra state. We had a healthy mix of students from every part of the country, and of course some very interesting ones from countries like Jordan and Tonga. It was a melting pot of sorts, and so was the teaching staff – from Russians to Bengalis, South Indians ('Madrasis' to all of us) to Punjabis, they

Image credit: Frits Ahlefeldt www.landscapesofunderstanding.com/photo/307/Computer-Brain-1-Color-illustration.html

were all there. And it made no difference to us what caste or creed they belonged to. Similarly, I do not recollect any employee of IIT who was from Powai or its vicinity. The entire area outside the gates was as rustic as it probably was before IIT stepped in – one small Udipi restaurant 'Ramakrishna Refreshments' (RK in our lingo), a couple of cycle and puncture repair shops, not even a shelter for our two bus stops at main gate and Y Point.

Karnataka has been allotted an IIT, and politicians are falling over each other trying to get it into their constituency, as though all youngsters in their region will become IITians, or that hundreds of their poor will get employed. Considering the above factors, I wonder why there is so much debate about which part of Karnataka the latest IIT should be located.

To set at rest the vigorous lobbying, let us get a few facts straight. An IIT, regardless of where it is located, admits students on an all-India basis. Hence ideally the new IIT should be located away from all major cities, preferably in a calm and serene location, connected by a good road to a railhead which is less than an hour or two away. There is no need for the institution to be near an international airport. It will help if the area has some tourist interest though.

When the land is allotted, there should be a 10-12 year plan before undergraduate classes start. Tree planting and water harvesting schemes should first begin. An artificial lake should be created and fed through rainwater. Road to the nearest station should be improved and a regular bus service should be started.

If 25 to 50 acres could be acquired opposite the campus, the government could set up a tourist holiday resort, which can also act as a guest house for the institution. If an ITI or polytechnic can be established, it will be a feeder for the technicians who will be required in the coming years, and degree students will get an exposure to the practical side.

The next step would be to start building small but comfortable and picturesque bungalows for the teaching and non-teaching staff. A Kendriya Vidyalaya can be established, initially

admitting all students from the vicinity, and gradually moving on to providing education on priority to children of IIT staff.

At this stage one hostel could be constructed, and periodic workshops and short-term training programs could begin, with professors being invited to come with family and stay in the resort. An exclusive air-conditioned shuttle service could connect participants to the railway or bus station nearby. Taking things forward at this stage, a few shops selling basic essentials, some sports facilities, summer camps for students from any part of the country, and trekking activities could commence.

During this phase, more than airport connections, the campus should have excellent wi-fi connectivity and good maintenance of all hardware. An industrial estate can also be set up nearby to cater to the needs of the institution and also give direct exposure to students who could do internships in the small industries. Please note that investment in all the above can be recovered in a few years since they will be generating their own revenue.

There is much talk about industry-interface, and that the institute should be located at a place where IT companies, MNCs, etc. are located. I beg to differ. Students will have ample time to interact with industry if they graduate with a good foundation. What they need is interaction with the common man, the rural sector. If they can be encouraged to go out to neighbouring villages on weekends, they will learn a great deal about life, and their attitude will be much more positive. In our days there was hardly any industry interface, and no campus recruitment, but I don't believe we were any poorer because of that.

A long term plan could be to have a small runway or helipad so that when the institute starts generating sufficient funds, a small aircraft or helicopter can connect residents to the nearest airport.

All the above can become reality only if we understand that IITs are primarily meant for good fundamental education in all areas of technology, and that industry-interface or incubation of start-ups is only secondary, which a student can go to the city and acquire after getting a strong and relevant education. Also, IITs should not be reduced to IIITs (i.e. Indian Institutes of Information Technology), and they should encourage all branches of engineering which may in fact grow and become more popular in the years to come. Many branches of engineering have seen their ups and downs in demand, whereas an IIT should cater to the needs of the nation for at least half a century or more.

If there is no distraction of city life, both teachers and students will spend all their time in the campus, interact closely, build better relationships, participate in meaningful extra-curricular activities, and go back into the urban world having not only learnt their subject, but also having become mature, balanced and focused human beings. ♦

Ali Khwaja
B.TECH. MEMS, '74

A Montessorian, an engineering graduate of Institute of Science and IIT Bombay, MIE, MIIM, with a PhD in behavioural sciences -- Ali has always carved out his own path and been a freelancer, ensuring that work is joy every day. He is invited regularly to conduct workshops or lectures for Defence, Central Government, prestigious National institutions, schools and colleges, but he prefers to be informal, learning while he teaches, and being honest and congruent in whatever he says or does.

Maha Varun Holi Tantra

The Experience and Science of Sky-water Tapping

SHREEHARI (RAJA) MARATHE

Introduction

Water is the elixir of life, and almost ¾th of the surface of earth is covered with seawater. A small part of seawater reaches our lands by means of clouds, which are generated by the uneven heating of the Earth's surface. The formation of clouds, their movement and dispersal through the Earth's atmosphere are very complex and interwoven phenomena, and armies of scientists, satellites, instruments and radars are devoted to their study.

This is "skywater" – the source of all groundwater in the form of rivers and lakes and underground water that has leaked into the Earth's surface. The origin of all skywater is the oceans and the clouds that carry it in the Earth's atmosphere. A very small fraction, less than 3%, of this flowing skywater reaches land in the form of rain and snowfall. The techniques of cloud seeding are concerned with extracting the optimum amount of rainfall or snowfall by injecting the clouds with certain chemicals that act as catalysts. The commonly-used chemicals are silver iodide in the case of cold clouds and sodium chloride and magnesium chloride in the case of warm clouds.

The transport of these chemicals to the clouds to the height of 1 km to 6 km is done by means of aircrafts, rockets or indirectly through thermal means on the ground. Maha Varun Holi Tantra is a simple low-cost ground-based cloud seeding technique suitable for Indian monsoon conditions which consist of mostly warm clouds, and sometimes warm cold clouds. The technique consists of simply making a fire, spreading on the fire twigs of latex-bearing plants such as vad and pipal, and sprinkling common salt in a continuous way.

Material required for each Holi Tantra Prayog

You will require a ton (10 quintals) of dry biomass such as wood, bio-briquettes etc. For the samidha, about 100 kg of wet twigs of latex-bearing plants such as wad, pipal, rui, umbar, etc., any of them will do. You will also require around 200 kg of common salt (NaCl). The approximate cost of each prayog is ₹ 10,000 including labour and transport

Holi enclosure construction

A holi enclosure can be constructed by making around 16' diameter circular structure on the ground. It requires about 600 bricks or 300 cement blocks. The structure has ventilation holes and a passage to enter or exit.

Holi enclosure location

Pick a spot where, if possible, there is natural or man-made protection from wind like a school ground or river basin, or inside a dry lake or pond. It should not be set up on hilltops (with the mistaken belief that it will be near the clouds!) but at the base of hills where up currents can carry salt vapours upwards and not sideways.

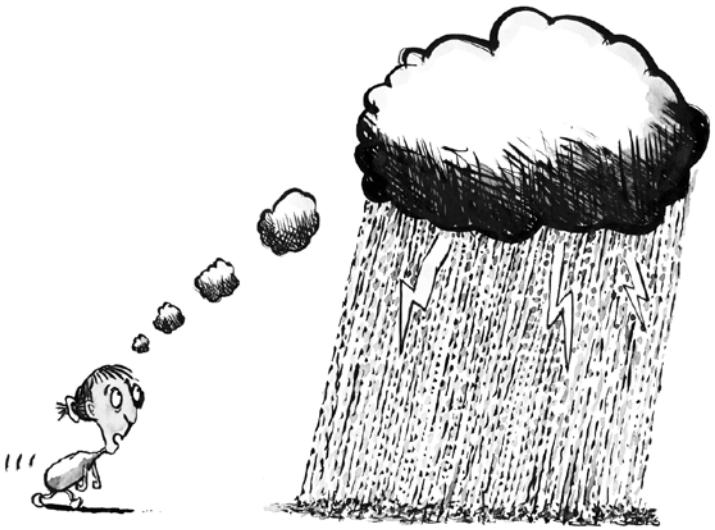


Image credit: Frits Ahlefeldt www.hikingartist.com/2015/09/19/creating-your-own-weather/creating-own-worries-rain-clouds/

Holi timing

There should be good dark cloud cover in about 70 to 80 % of the sky. There should be high relative humidity and very little wind, with temperature below approximately 28°C. If there are Cumulonimbus clouds (shape of cauliflower) around, that is very good. A good time is around 7 AM or any time when the above conditions are present. Not effective at night when the thermals are absent. The experience of the past 4 years indicates that this results in a good rainfall over 5 km x 5 km area in 2 to 48 hours. A Doppler weather radar will be able to advise on the correct time at each location.

Tantra of Maha Varun Holi

Arrange the 1 ton of wood inside the Holi Kund in a circular shape with small twigs below. Cover the wood with samidhas of twigs of latex-bearing plants such as wad, pipal, umbar, rui. Start the fire around 7 AM or during the day when the cloud cover is good. Let the fire continue until all the wood is exhausted. It may even take a day and night. The remaining salt-containing ash, after it is cooled, should be removed and can be used for the subsequent experiments.

How many times and where?

The Varun Holi Tantra should be continuously done for a period of 3 days or until the rain starts. It is more effective if it is done simultaneously at several locations spread 5 km apart. Cover the samidhas with salt in an even manner. The number of locations can be 10, 100 or even 1000! The simultaneous performance increases the salt content in atmosphere and can even create clouds in humid conditions. The common salt is quite harmless and has no environmental side effects.

Background

How was this technique arrived at? I did a Partnership Farming Project in village Sujlegaon, district Nanded of Maharashtra in June 2009.But there were no rains until 10th August 2009. The villagers approached me as a scientist and asked if I could do anything about the situation. I did some research on artificial rainmaking techniques and in the process contacted Prof Shivaji Rao through the Internet and he sent me his book "Cloud seeding for India – An effective weapon to fight drought".

After going through the book, I got the inspiration from James P. Espy's suggestion in 1839 to burn large blocks of wood to create clouds. In desperation to save the crops, I made a bonfire on 19th August 2009 in Sujlegaon and sprinkled salt on flames. To my utter surprise, in about 2 hours rainfall started and we got 5 mm of rain. That saved the crops! And what was interesting was that the rainfall was restricted to about 3 surrounding villages covering an area of about 5 sq km. As the

"Hostel Ten was always a bit coveted for the PAFs – though this did not always mean that they took first prize. For a month or so the hostel would see feverish activity - and a boy influx – until we would see the girls on stage, mostly lovely and talented."

news spread quickly in the villages, another farmer Shri Deshpande from a nearby village of Navandi performed similar experiment in his village and that too resulted in rainfall. The same result was achieved in village Rudrur of nearby Nizamabad district after a couple of days. This quick succession of three results motivated me to try this technique on a larger scale in the surrounding areas.After its discovery in August 2009 in Nanded district, more than 100 experiments were done in 2009 in Nanded, Hingoli and Latur district. Almost 70% resulted in rainfall within 2 to 48 hours.

I presented the technique at the Innovation conference conducted by the Pune Chapter of IITB Alumni Association in 2010. Through the Alumni network, I met Shri Prataprao Pawar, Chairman, Sakal group in May 2010 and demonstrated the technique successfully in Lonavla. The Varun Holi Tantra has been extensively popularised in Maharashtra during 2010 monsoon through the Sakal group of publications by the enthusiastic intervention of Shri Prataprao Pawar. In June-July 2010 I made a tour of Maharashtra and have personally conducted more than 100 demonstrations which were carried out in Pune, Satara, Kolhapur and Sangli districts, and the technique received widespread publicity in all Marathi papers such as Sakal, Lokmat, and Agrowon. In 2011 I was interviewed by the Krishidarshan program on Doordarshan and received more than 5000 phone calls. Over 1000 experiments were subsequently done all over Maharashtra. In December 2012 a massive experiment of simultaneous Varun Holi Tantra in 120 villages of Malshiras taluka of Solapur district under Shivamrit Doodh Dairy resulted in 80% villages getting rainfall. Despite this vast amount of awareness in Maharashtra, it is unfortunate that very few farmers are independently using the technique.

Science of warm cloud seeding

A cloud is a two-phase system containing water vapour and water droplets. It is a viscous medium containing water vapour (size < 1 micron) and water droplets (~ 10 microns). The colour of the clouds is an indication of the water droplet density. If the density is more, less light passes through the cloud, making the cloud blacker. Raindrop size is around 1 to 2 mm. About a million small droplets have to come together to make one raindrop. The process is called Langmuir chain reaction, named after the scientist who discovered it.

Rains: Langmuir Chain Reaction

The water droplets have a random Brownian motion in the clouds. If conditions are favourable, then two drops will stick together ("coalesce") and a new, bigger drop results. The larger droplets in the viscous condition of clouds fall faster than small droplets (mass grows as cube of radius, cross-section grows the square of radius). Hence terminal velocity

of larger drops is higher. This differential rate of descent results in larger drops gobbling up smaller droplets, and becoming bigger and bigger. A chain reaction! The drops of 1 mm to 2 mm diameter reach the ground as rain, smaller droplets evaporate back into the clouds.

Why cloud seeding works?

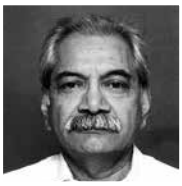
The key principle is to increase the number of drops sticking together (coalescence) when they hit each other (collision). Cloud seeding aids natural processes of rain formation and acts as a catalyst in speeding up the rate of raindrop formation. The droplets are made of 'distilled' water evaporated from the seas, and have a neutral electrical field around them. When salt (NaCl) goes into the clouds, it dissolves into the water-forming weak saline solution. As NaCl is an ionic substance, the positive Na ions and negative Cl ions change the electrical field and the water droplets become like electrically-charged balls. Thus when two such droplets run into each other, the chances of their sticking together and becoming bigger increases.

Scientific Hypothesis of Varun Holi Tantra

In the fire, the latex-bearing plants start burning. The salt sticks to the leaves and ash and goes up as smoke. The smoke rises to 50-100 feet by natural convection and gets injected in the base of the naturally occurring thermals in the atmospheric boundary layer. The thermals (like gliders, birds) carry them to 3000 feet at the base of the clouds. The salt reaching the clouds acts in the manner explained earlier. This increases the chances of rain starting, and if started, the rainfall increases.

Conclusion: Rain drives the economies of countries like India and China where a large component of agricultural production is determined by the rainfall pattern during the monsoon season. Hence its control should form an important component of national security. The Chinese have taken important steps since 2005 and have set up the Weather Modification Authority of China which employs more than 100,000 scientists and technicians. It also has a nationwide network of Doppler radars and a vast array of airplanes and rockets and a mechanism for their deployment and use.

Alumni support: It would be helpful if some generous alumni can take some active interest in promoting this technique in India.



Shreehari (Raja) Marathe
B.TECH. ELEC E, '68

Shreehari (Raja) Marathe has 25 years of IT experience and 8 years experience in working with farmers in Maharashtra. He graduated from IIT Bombay with a B.Tech degree in Electrical Engineering in 1968 and received his Ph.D. degree from Rice University, USA in 1973. He made design contributions to the first Param Supercomputer while working as Professor at NIBM. Dr Marathe is well known in Maharashtra for his work on ground-based cloud seeding. He lives in Pune.

Creative Bees at Fundamatics

ILLUSTRATION

Shreyas Navare
M MGMT, SJMSOM, '08,

Shreyas Navare, Mumbai, Senior Manager, Marketing and Corporate Communications at a private bank. He freelances as a Editorial Cartoonist for Hindustan Times. He has covered elections in 6 Indian states through the eyes of a cartoonist on behalf of HT. Shreyas has held many cartoon exhibitions, two of which were inaugurated by Dr. A. P. J. Abdul Kalam. His first solo international cartoon exhibition was held recently at Bangkok. His second exhibition was held at Nehru Centre recently. Cartoons featured in this issue are from the exhibition.

Arun Inamdar

Arun Inamdar is an example of the breadth and depth of talent in IITB. A geologist by training and a professor at the Centre of Studies in Resources Engineering, he is a perceptive cartoonist and caricaturist with a soft corner for the campus and its ecology. His caricatures have brought smiles to an array of celebrities who have visited the campus and his cartoons hold up a mirror to our follies without causing offence. An alumnus of C76, he can be depended upon to come to the rescue of the ACR office and IITBAA with his talent at very short notice.

EZINE

Abhishek Thakkar
B TECH, CIVIL E, '03

Abhishek Thakkar or just 'Thakkar' as he was known throughout campus is an alumnus of H5 from '03. Having a lot of it, he loved throwing his weight around, and escaped many a bumps which he'd have got for his PJs. Now he channels all that creative energy in designing beautiful, scalable web and mobile interfaces.

DESIGN

Anand Prahlad
M DES, IDC, '07,

Anand Prahlad is an independent graphic designer and artist. When not designing books, magazines, logos or illustrating, he is an active gardener, culinary expert and amateur musician. He runs www.magic-marinade.com, a food and travel blog, and also www.thenewvitruvianman.com, where he writes and illustrates articles on design, gastronomy and music.

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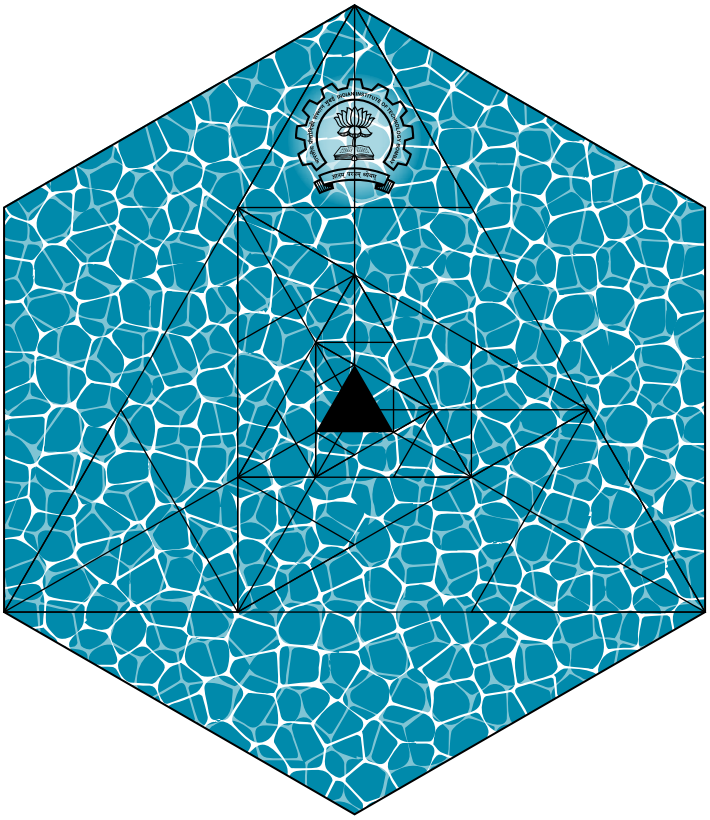

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