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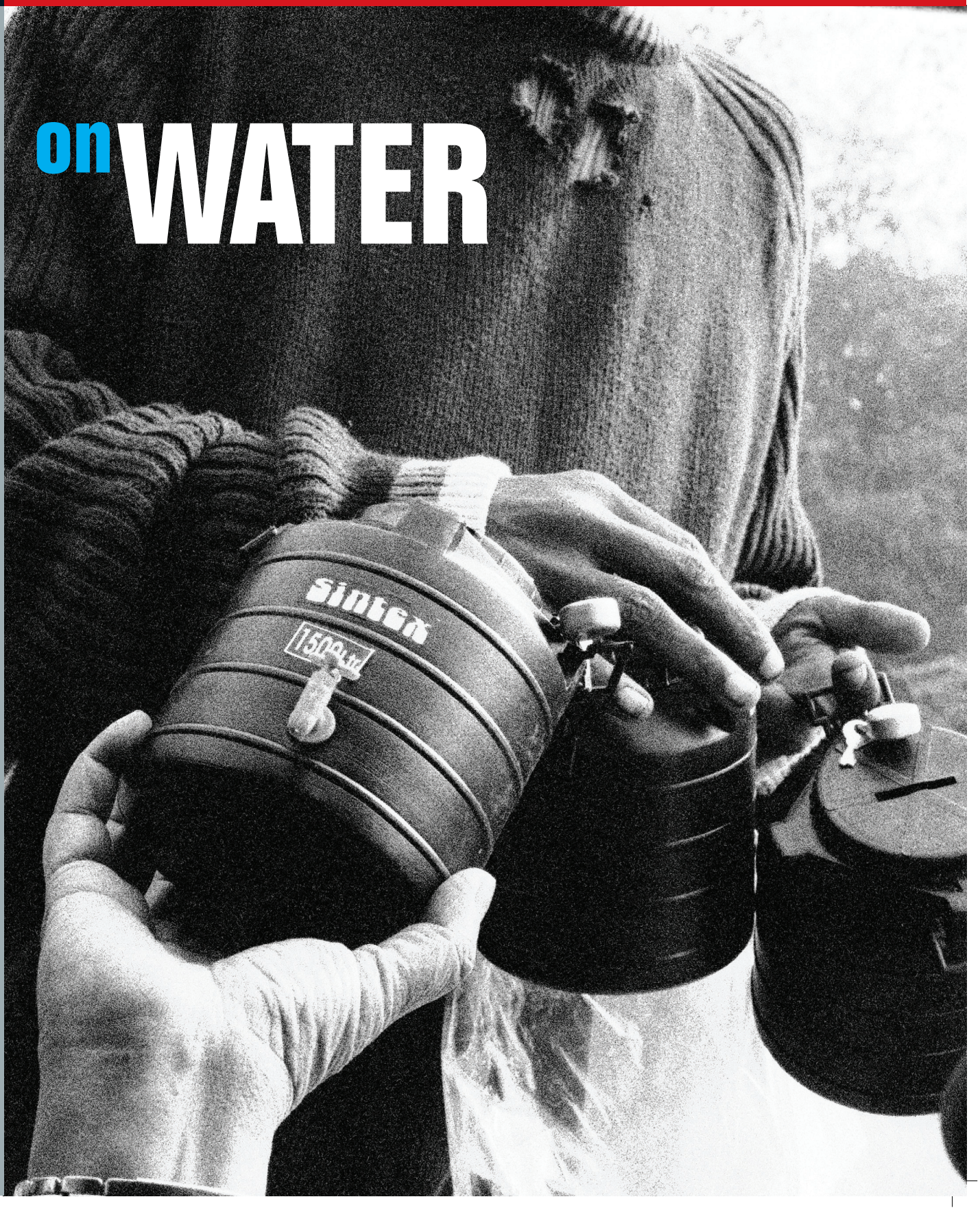

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RISE, FALL AND POTENTIAL OF INDIA'S TRADITIONAL WATER HARVESTING SYSTEMS

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-Anna Hazare, social activist

This book is a passionate plea for going back to the roots of Indian traditional skills to overcome the current water crisis...India's planners must make it a compulsory reading.
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River conservation

The government has given importance to the problem of river pollution with the establishment of a National River Conservation Authority chaired by the Prime Minister.

Unfortunately, river conservation programmes will be effective only if the ecological, economic, technological and social dimensions of the problem are seen in a comprehensive manner. What ultimately flows down the river is the result of a lot that happens outside the river.

The Ganga Action Plan was mainly conceived to deal with the municipal sewage flowing into the Ganga. Industrial sewage treatment was supposed to be managed by the individual industrial firms. But a number of economic problems were not adequately addressed. Cost of treatment is high and many municipalities are not able to afford the costs. If the municipalities cannot pay for the operational costs of these treatment plants, river conservation programmes will only demand perpetual subsidies.

Only a very small section of the country's urban population benefits from sewerage systems and this section consists of the richest urban people. There is no reason that the government should subsidise this section. The high cost of sewerage systems means that only a small fraction of India's population will benefit from them. A large proportion of the urban population in India still uses the open environment for its ablutions.

It is also an ecologically mindless technology. Firstly, large reservoirs have to be built or large amounts of river waters have to be diverted to supply cities with water that can be flushed down the toilets and, then, this water accumulates in the form of concentrated sewage flows into rivers and destroys the rivers.

It is, therefore, important to take a long-term view of India's strategy for human excreta disposal. Various alternatives are being tried out in different parts of the world, which do not use any water, or use very little water. Current research expenditures in this area are next to nothing.

Secondly, river conservation programmes must take a larger perspective of pollution. At the moment, a major source of pollution — that is, pollution from agricultural fields in the form of chemical fertilisers and pesticides — is not being tackled at all. Where such fields are upstream of the drinking water supply intake points of cities, the pollution goes straight into drinking water because treating for chemicals in water is extremely expensive and is not undertaken in India. Delhi's water supply is a case in point as Delhi sits downstream of the agricultural farmlands of Haryana.

The government must, therefore, encourage farmers to move towards organic farming, failing which they must be encouraged to use biological pesticides or safer chemical pesticides and undertake integrated pest management to reduce the use of pesticides. In other words, we need comprehensive river basin pollution control programmes.

One way to deal with the problem will be to permit water quality rights of citizens. State governments are responsible for implementing water pollution control laws. But many states prefer to encourage indiscriminate urbanisation, industrialisation and agricultural development totally disregarding the health implications of water pollution for people living down stream.

Recently, people in Rajasthan have suffered epidemics resulting from polluted waters coming from Haryana. Citizens who depend on water from inter-state rivers, should have the right to demand that the water entering their state be of a certain quality, so as not to be a threat to their health or impose on them excessively high water treatment costs. Pollution control and prevention costs should be borne by the polluting communities upstream and not the affected comunities downstream. These rights, should allow citizens of a downstream state, to sue the state government upstream responsible for pollution control and prevention. The health costs of polluted water in Delhi would run into several thousands of crores a year. If Delhi's citizens were to sue Haryana for this amount, this would put pressure on state authorities not to be lax.

Thirdly, it is vital to start thinking in terms of urban water conservation and demand management programmes. Overextraction of water from rivers is today a serious problem. The Delhi Water Supply and Sanitation Agency today claims to supply about 200 litres per capita per day for domestic consumption and is planning to increase the average domestic consumption to 225 litres per capita, per day by 2001. By contrast, domestic consumption in Copenhagen, one of the richest cities in the world, is only 138 litres per person, per day and the government hopes to take it down to 110 litres per person per day by 2000 AD. The government has steadily increased water supply prices and used the extra revenue to reduce leakages in the public distribution system.

One other approach for water demand management is to promote rainwater harvesting. High quality water need not be supplied for all uses. For instance, for cleaning floors, for gardens, for washing clothes, for flush toilets and other such uses harvested rainwater without any treatment can be used. Several European cities, including Copenhagen, are encouraging the use of rainwater for such uses. Rainwater harvesting should be made compulsory for all urban households. Madras is one city which has taken a lead in this regard and the whole country can learn from it.

River conservation will, therefore, have to be a joint effort of agriculturists, industrialists, urban managers, ecologists and economists apart from government regulators. It cannot just be a pumps and pipes scheme, which so pleases the hearts of contractors and civil engineers. ■

Anil Agarwal

Only a very small section of the country's urban population benefits from sewerage systems and this section consists of the richest urban people

The water business

WATER has become a new pet subject for Indian industry. Not because it is concerned with the depleting water resources or its own contributions to growing pollution. Because it sees a new and lucrative business opportunity. With support from the World Bank, the Confederation of Indian Industry (CII) and other associations are competing with each other to establish their role in the water business. Last month saw a spate of conferences on this issue, with industry participants drooling about the huge investment requirements for drinking water and sanitation.

I am not against private sector involvement in water *per se*. But given the political economy of water and sewerage in the country, I believe their role will be extremely limited. The simple assumption of private sector proponents is that if water is correctly priced – what is known as full cost pricing – it would facilitate investment from the private sector and provide a solution to the water crisis facing vast regions of the developing world.

This argument has many holes unfortunately. Firstly, current water and sanitation technology, based on the flush toilet and sewage system, would make full cost pricing of water and sanitation services unaffordable by most in the urban South. It is important to recognise that private sector involvement cannot be only in the water supply business. This is just one small and profitable part of the water business. The real cost is in taking back the sewage and treating it to the quality needed for disposal in water bodies. This is the real "dirty" business. We know that sewage and drainage costs can be as high as 5-6 times more than the cost of water supply. And with increasing chemical pollution, water treatment costs are only going to increase.

The political economy of defecation is such that no democratic government will accept the hard fact that it cannot "afford" to invest in modern sewage systems for its citizens. Instead it will continue to subsidise the users of these systems, in the name of the poor, who would not be able to afford the systems otherwise. It is important to realise that almost all users of the flush toilet and its sewage system are the rich in our cities. Our political system today literally subsidises the rich to excrete in convenience. In fact we get a double subsidy.

The logical policy would be to accept the cost and then to impose differential pricing so that while the rich pay for the cost of the capital and resource intensive sewage and waste disposal technology, the poor pay for the cost of their disposal system, which is invariably unconnected to the sewerage system and hence low cost. But this is easier said then done.

The democratic framework in our countries would force political leaders to keep water and waste pricing affordable by large sections of urban populations. In this situation you will find that private investment looks for an easy way out. The answer is to invest in water services and to leave the costly business of cleaning up the waste to government agencies. In most parts of the developing world, the water industry is bidding and securing contracts primarily for the profitable water business. This will lead to a distortion in the prices, as profits will be creamed off, while costs will be left to the already strained public exchequer.

In India, industry has been lobbying for private investment in the water sector. But it would like to focus on the water supply business. Or at best it would like to build and operate the treatment plants but will leave local governments to price and recover costs from consumers.

Secondly, the private sector will have little to offer to large numbers of urban poor. Most poor urban dwellers are illegal occupants — living in slums and highly congested areas. The cost of reaching and maintaining services to these groups is expensive and there is uncertainty about recovery of dues. The risks are high. The profits low. In this situation, private investment is rarely available.

Thirdly, private sector with its *mantra* of full cost pricing does not even begin to have answers for the millions of people living in rural South. These communities already pay an enormous cost for water. In fact, here the community sector has an enormous amount to offer. Given the state-dominated water supply systems, little effort has been made to get rural communities to develop and manage their own water supply systems. But where done, it has shown outstanding results, including the willingness of rural communities to contribute substantially (labour in a big way and materials to a lesser extent) to the construction and maintenance of the water supply systems. This reduces the cost of water supply to the public exchequer and gives ownership to the stakeholders of the water supply projects. Community-based water management has the potential to become the world's biggest cooperative enterprise.

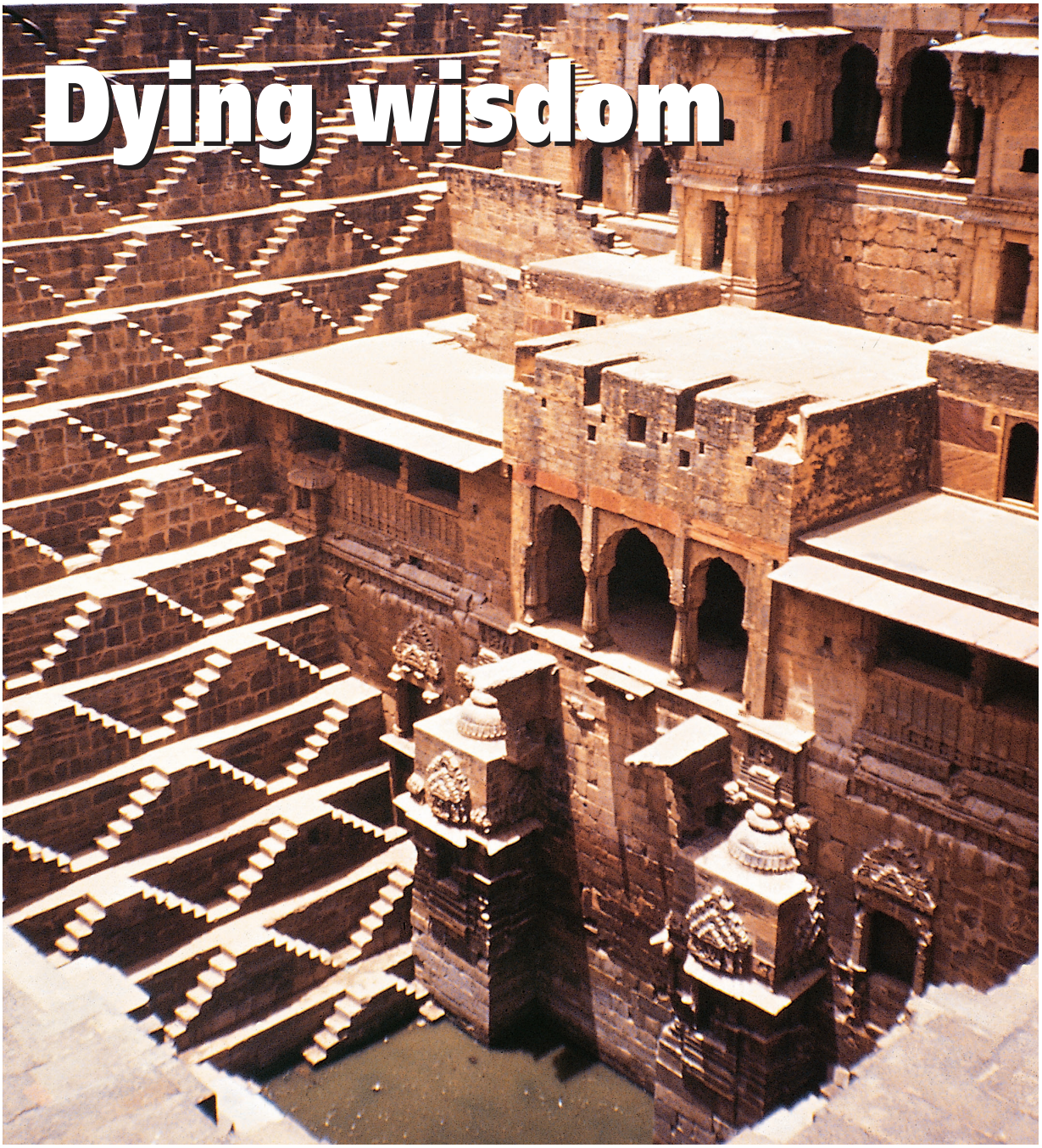
Rural communities need is financial support for creating conditions that lead to self-management of water sources. The answer is not full cost pricing but political decentralisation and empowerment.

It is this community-industry-government collaboration that we must build in urban areas as well. Public participation and political process that pushes for good governance in water management are the key prerequisites for change. Not another contractor. ■

— Anil Agarwal

Given the state-dominated water supply systems, little effort has been made to get rural communities to develop and manage their own water supply systems

Dying wisdom



ANUPAM MISHRA

The jhalara *of Bundi: an open stepwell capturing subterranean seepage. Water harvesting structures often went beyond functional use. They became human creations of exquisite beauty*

Rise and fall of traditional water harvesting systems in India

They are called *kuhals* in Jammu, *kuls* in Himachal Pradesh and *guls* in Uttarakhand. The Maharashtrians call them *pats*. In Ladakh, they are called *zings*, and in Nagaland, *zabo*. Tamilians call them *eris*, Kannadigas, *keres*. Rajasthanis have *tankas*, *kundis*, *bawdis*, *jhalaras* and a host of others. Traditional water harvesting systems exist all over India, but after serving the nation for several millennia, they are dying a slow death. **Anil Agarwal** highlights the key findings of the *Fourth Citizens' Report on the State of India's Environment*, a product of five years of research, which focuses exclusively on India's water harvesting tradition. The report will be released by the Centre for Science and Environment this month

Drought-struck villagers of Sukhomajri (Haryana) have found solace through their small water harvesting tanks. Today, from a food-importing village, Sukhomajri has become a food-exporting one

ANIL AGARWAL / CSE

While water harvesting took Sukhomajri from poverty to plenty...

ANIL AGARWAL / CSE

...it turned Ralegan Siddhi into a 'model' village of sustainable development

THE year 1979 had seen a debilitating drought sweep across India. As rains failed, agricultural production dropped, resulting in enormous human misery. Nestled in the denuded sub-Himalayan Shivalik hills, the poor villagers of Sukhomajri in Haryana were not spared either. They had managed to grow just one monsoon crop a year in normal circumstances; this year, they were not going to get even that.

However, even in this desolate landscape, there was a ray of hope. P R Mishra, a soil conservationist who was trying to get the villagers to stop grazing their animals in the region's degraded watershed, had earlier in the year worked with them to build a small earthen dam across the seasonal stream that ran through Sukhomajri. Desperate for the water stored behind the dam, the villagers appealed to the soil conservationist to help them make channels for conveying the water to their fields. But before giving his assent, Mishra told the villagers that if they did not stop grazing their cattle in the watershed now, their own dam would get silted up very fast and they would not have this water when the next drought hit the village. The villagers agreed to take care of the watershed. Thus, good water management through small water harvesting tanks gave birth to a pioneering village-based natural resource management system which has since inspired many Indian environmentalists and village workers.

Today, the village has several such water harvesting structures and can grow three crops a year regularly. From an essentially food-importing village, it has become a food-exporting one. And with grass productivity increasing and trees regenerating, the region now has so much fodder that the villagers have given up their goats in favour of high-yielding buffaloes; they sell several lakhs of rupees worth of milk to neighbouring towns. Says economist Gopal Kadekodi at the Institute of Economic Growth in New Delhi, "The rate of return from this project cannot be matched even by the corporate sector."

Around the same time, in the mid-'70s, a jeep driver in the Indian army had returned to his parched village, Ralegan

A history of harvesting

India has had a tradition of water harvesting which is more than two millennia old

The nature of Indian ecology forced Indians to develop the art of water harvesting. Though the nation gets a high amount of rainfall — as much as 1,100 mm per year — this rainfall is not evenly spread across the year. Most of the time, even in a year blessed by normal rainfall, the country faces a drought. Says eminent meteorologist P R Pisharoty, "Rainfall is largely concentrated during four months of the year. But then too, it does not occur daily. In most parts of the country, there is precipitation during not more than 50 days. On the days when rainfall does occur, it does not fall over a period of 24 hours. In fact, heavy showers are common. Most of the country receives rain for just about 100 hours each year." The remaining 8,660 hours in a year get no rain.

Not surprisingly, any water gifted by the heavens or flowing past in a stream has been harvested in India since antiquity. Says archaeologist B M Pande, "Evidence of this tradition can be found in ancient texts, inscriptions, local traditions and archaeological remains. There is some evidence of the existence of advanced water harvesting systems even from pre-historic times. Hindu texts like

Another success story is that of Anna Hazare's Ralegan Siddhi (Maharashtra); harvesting rainwater to enrich the region's groundwater reserves has turned Ralegan into a model village

Aizawl's (Mizoram) residents tided over their problems of scarce water by resorting to rooftop water collection and developing an independent water supply system

the *Puranas*, *Mahabharata* and *Ramayana* and various Vedic, Buddhist and Jain works contain several references to canals, tanks, embankments and wells." The first reference to the hydrological cycle in the world comes from the *Chandogya,* one of the principal *Upanishads* (the philosophical reflections of the Vedas) which points out: "The rivers... discharge their waters into the sea. They lead from sea to sea, the clouds raise them to the sky as vapour and release them in the form of rain." This reference shows that as early as 1000 BC, attempts were being made to interpret and explain recurrent natural phenomena on the basis of direct experience.

A newly excavated water tank, constructed in circa BC 100 at Sringaverapura near Allahabad in Uttar Pradesh

B B LAL

Of particular historical significance is the evidence that has recently come to light in Dholavira, a major site of the Indus Valley civilisation, dating back to the third millennium BC. The site is located in the Great Rann of Kutch, and was one among the five largest Harappan cities excavated so far. Discovered in the 1960s, Dholavira lies in an arid area which gets an average annual rainfall of 260 mm. There are no perennial sources of water in the form of lakes or rivers. Subterranean water is, by and large, brackish and saline. The inhabitants of Dholavira, therefore, created several reservoirs to collect the monsoon runoff flowing down the flanking streams of the Manhar and Mansar. Stone bunds were raised across them at suitable points to divert the flow of water into a series of reservoirs which were dug out in the sloping areas between the inner and outer walls of the Harappan city. Likewise, a network of drains crisscrossing the citadel was also laid out to collect rainwater.

In his book *Arthashastra* (fourth century BC), Kautilya, the mentor of India's first emperor, Chandragupta Maurya (BC 321-297), speaks at length about the need to construct irrigation systems and reservoirs and sets out rules for collecting revenues and for fines to be imposed on those who do not observe state rules set for the good management of these tanks — a tradition which was carried over through the centuries.

Wherever villagers had kept their kundis *— wells with artificially created catchments — they had water to drink even in the mega-drought of '87 when piped water schemes failed across the Thar desert*

ANIL AGARWAL / CSE

Siddhi, in the drought-prone district of Ahmednagar in Maharashtra. Faced with intensive land degradation, denudation and dried-up water sources, the village had fallen victim to massive male migration, rampant illicit liquor brewing and heavy alcoholism. Krishna Bhaurao Hazare, the jeep driver, took a decision which was to change the face of his village. He began organising the people for constructing small dams across the various seasonal channels that went through and around the village, so that every drop of rain could be harvested and allowed to percolate into the soil to enrich the groundwater reserves. With the help of the increasing groundwater, the villagers slowly began improving their agriculture by using water-conserving crops. In the last two decades, the dramatic change in the economy of Ralegan Siddhi has made it a model village, attracting nationwide attention. Krishna Bhaurao, who has also become a leading crusader against government corruption at the grassroot level, is popularly known today as Anna ('big brother') Hazare.

Tarun Bharat Sangh (TBS), an NGO working in the drought-prone district of Alwar, which straddles the Aravalli hill chain, has a similar story to relate. Rajendra Singh of the Sangh began encouraging the region's villagers to take their destiny in their own hands and revive their traditional water harvesting systems called *johads,* which consist of earthen dams thrown across seasonal channels. But unlike a normal dam, the rainwater here is collected during monsoon and allowed to percolate into the soil. Beginning in the early '80s, the TBS has by now constructed nearly 1,200 *johads* ensuring assured crop output in about as many villages in the region.

During the drought of 1987 — probably the worst of the century — journalist Om Thanvi had scoured the Rajasthan desert to assess the state of the region's water harvesting systems. An acute shortage of drinking water marked the region, with government agencies desperately trying to reach water to far-flung rural communities on trucks. Thanvi was amazed to find that wherever households had not given up their traditional rainwater harvesting systems called *kundis*, the urgency for the government water tankers was much less or non-existent. Following the drought, the government actually began to encourage the construction of such structures and the villagers also learnt an important lesson: Keep your own *kundis* intact while welcoming the extra water the government supplied.

In the hill-top town of Aizawl, the capital of Mizoram — a region known for its heavy downpours — local residents found that increasing urbanisation had led to denudation and destruction of mountain springs, thus creating an enormous water scarcity. The town, facing an unmanageable expenditure running a fleet of trucks up and down the steep hills ferrying water from the river in the valley below, decided to encourage rooftop water collection. Today, almost every house in Aizawl has developed its own independent water supply system.

The premise is clear: India, after having gone through an extended 50-year phase of constructing big dams and canals, is once again being forced to look at its traditional, smallscale water harvesting and management systems — especially amongst grassroots organisations which are working with the people to develop cheap water management systems that the people can themselves manage. ■

Revival of* johads *in Alwar has helped a thousand villages to fight drought

GANESH PANGARE

The legacy of Bill Willcocks

Bengal's history provides an eye-opener in the form of the opinions of a British irrigation expert

In India's flood plains, the people developed ingenious techniques to use the menacing floodwaters, not just to irrigate their fields but also to fertilise them and control diseases like malaria (by making use of fish in the floodwaters to eat away mosquito larvae, for instance). The nation's richest agricultural area in pre-British India, the flood plain of Bengal, had developed an extraordinary mechanism for harvesting the rich floodwaters. With agricultural production declining rapidly in once prosperous Bengal — for instance, the paddy yield in Burdwan district dropped from an average of 1.12 tonne (t) per acre in the period 1871-76 to 0.75 t in 1924, with the net cropped area dropping from 68 per cent of the district's total land area in 1871 to 38 per cent in 1921 — the British government invited William Willcocks, a British irrigation expert, to advise it on irrigation development in Bengal. In a series of lectures delivered in Calcutta in the 1920s, Willcocks, who was known for first talking to the local natives before making up his mind, stunned everyone by arguing that the absolute best that the government could do was to revive the ancient flood irrigation system of the region.

When Willcocks tried to plan a system of irrigation canals for the Bengal countryside, he was astonished to find that every 'dead river' on the map sheltered an appropriate place for a canal. To his discerning eye, the parallel alignments of the main canals, maintained over long distances, contrasted sharply to what he called "the tangled meaningless mass of waterways... where we have nature's undirected handiwork."

Willcocks tried to investigate these dead rivers, locally called *kana nadis* (or blind rivers). He concluded that during floods, the embankments along these canals would be regularly breached to take the floodwaters to the fields. But the British administrators had misunderstood them for flood embankments and considered the regular breaches in them as discreditable occurrings. Therefore, the

Traditionally, people have devised an immense variety of simple techniques to harvest or store water for their use. An and Madhya Pradesh's *haveli* system which uses cropfields themselves as reservoirs

A. Diverse technologies: a treasure trove

Our traditional water harvesting structures demonstrate the people's ingenuity at its best. Using unique modes and basic engineering skills, Indians have developed a wide array of techniques for satisfying their thirst

ANIL AGARWAL / CSE

The Angami tribespeople of Nagaland ensure that the catchment of streams irrigating their terraced fields are well-forested. Such streams bring rich nutrients from the forest floor

India has an extraordinary diversity of agro-ecological systems, ranging from the hot desert of Rajasthan to the cold desert of trans-Himalayan Ladakh, from the sub-temperate Himalayan mountains to the high tropical mountains in the south; interspersed are various hill and mountain ranges, plateaus and the unique Indo-Gangetic plains which are more flood-prone than any other part in the world.

government did not do anything to desilt these canals and maintain them. Even worse, wherever possible, they constructed solid embankments to prevent wholesale breaches. "But," says Willcocks, "it ought to have been evident that 40-50 breaches in a heavily embanked river of inconsiderable length could not possibly have been made by the river itself."

The resulting destruction of the overflow irrigation system of Bengal steadily led to a decline in agricultural production, increase in malaria and the famous famines. Willcocks cites the specific example of how several embankments were raised around the Damodar river and earlier ones strengthened "like Satanic chains" — all of which were earlier regularly breached — and thus "doomed the once healthy and prosperous tract between the Damodar and the Hooghly which started facing the problems of malaria and poverty." In the 1930s, eminent economist Radhakamal Mukherjee described the lack of flush irrigation in Bengal, particularly in Burdwan, Hooghly and parts of Bankura and Midnapore, as a "red water famine".

Hill areas: convenient modes

Traditionally, wherever there were streams, especially in the hill and mountain regions of India, people diverted the water with the help of simple engineering structures, into artificial channels that would take the water to agricultural fields. In arid and semi-arid regions, where streams were more seasonal, the diversion channels were first directed into a storage structure — variously called a *zing* in Ladakh, an *ahar* in south Bihar or a *kere* in Karnataka — so that the water could be used in the dry period for human and animal consumption and for agriculture. Stream flow in the desert of Ladakh, as it is dependent on glacier melt, is almost non-existent in the morning but heavy in the evening — a time when cultivators cannot use it. Therefore, Ladakhis traditionally divert the evening flows into a small reservoir to use it next morning. In certain villages of the eastern Himalayan states of Nagaland and Arunachal Pradesh, the

mong these are storage structures of various kinds — *zings* (small reservoirs) in Ladakh, chains of tanks in Tamil Nadu

IPSHITA BARUA

In India's north-east, bamboo pipelines are commonly used to transport water to be used for drinking or for irrigating fields

villagers take the diverted channel through a cattleshed so that the water can pick up rich nutrients before it reaches their fields. The Angami Naga tribals ensure that forests above the main stream are never cut so that the streamwater remains full of nutrient-rich forest humus.

In fact, in terms of carrying water over a difficult terrain, the indigenous people of north-eastern India, traditionally expert in the use of bamboo, have developed some of the most interesting and artistic systems. All over eastern Himalaya and the north-eastern hill ranges, people continue to build bamboo pipelines to carry water from natural springs to a convenient point, where it can be used for drinking. But this art has been raised to a sublime level by the people of southern Meghalaya, living near the border of Bangladesh, who have used intricate networks of bamboo pipelines to deliver water to betel leaf plantations in rocky areas; it is impossible to build channels in such areas. The entire system literally works like a modern drip irrigation network which delivers measured quantities of water straight to the roots of the plants. Some 18-20 l of water enter the bamboo irrigation systems every minute and after getting transported over several hundred metres, finally get reduced to 20-80 drops per minute at the site of the plant.

Tamil Nadu: tank culture

Not all storage structures are riverfed or streamfed. Many of them simply collect water running off a catchment area to be stored for later use. But in the southern state of Tamil Nadu, a big stream is often diverted to feed a chain of 25-30 tanks in sequence. As this chain of tanks — called 'system tanks' — is served by a stream collecting water over a large catchment, it is traditionally considered much more desirable than a tank with a single, small catchment. Because of the wide variability in rainfall in both space and time, agricultural lands served by system tanks have always been more expensive and prized than lands served by standalone tanks. The Palar anicut (dam) system, for example, supplies water to 317 tanks, irrigating about 32,000 ha in North Arcot and Chengalpattu districts. Some tanks are supplied directly by channels coming from the Palar river, but several others depend mainly on the surplus flows of upstream tanks. The profusion of tanks in Ramnathapuram district of the state can even be seen from a satellite.

In western and central India

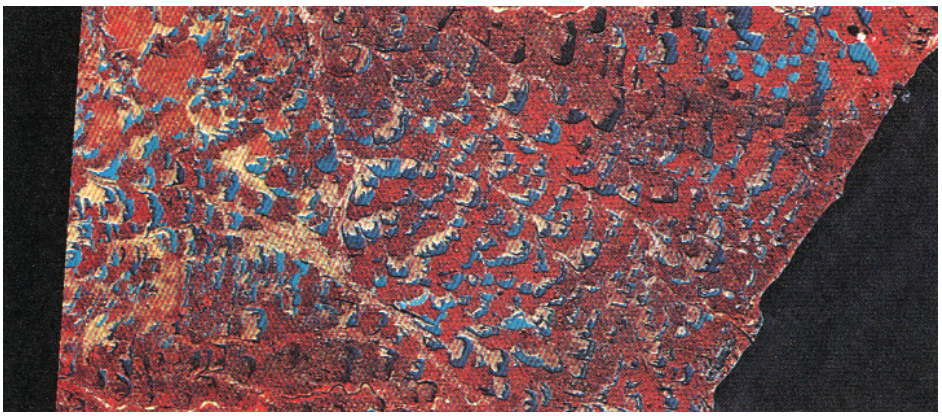
In several parts of India, people have been building dams across seasonal channels to capture the runoff. But these structures, unlike normal dams, are used to moisten the soil so that the post-monsoon crop would be assured of the rich soil of the tank bed itself. In the *haveli* system of Madhya Pradesh, the nature of the soils and traditional crops have forced farmers to store rainwater in the agricultural fields itself. The fields would be

GANESH PANGARE

A virda*: Maldhari tribals use these wells to store water*

In Tamil Nadu, a chain of tanks is served by a stream collecting water over a large catchment — a more desirable system than a tank with a single, small catchment

The nomadic Maldharis of Gujarat's inhospitable Kutch region build *virdas* — wells within tanks — so that sweetwater can be stored underground



NATIONAL REMOTE SENSING AGENCY

A satellite picture shows numerous tanks in Tamil Nadu's Ramanathapuram district. The Tamils often built a chain of tanks — 25-30 in a sequence — one feeding water into another

Jodhpur: providing an example

The most outstanding example of conjunctive use of water (prevalent in Rajasthan's arid regions) is in the city of Jodhpur, once a fabulously rich desert fort. The Jodhpur fort is situated at the edge of a rocky plateau. The former kings had built a series of canals to collect the runoff from the plateau and channel it into several tanks built in and around the fort. For houses that came up on the incline down the plateau, numerous stepwells and wells were constructed to capture seepage from the reservoirs above. In its 500-year old history, Jodhpur has witnessed many droughts, but never a desperation for water.

embanked and farmers would work out an arrangement amongst themselves to allow rainwater to flow from one field to the other. The collected water would seep into the soil and give it enough moisture for growing a good crop in the following dry period.

The nomadic Maldharis of Gujarat's inhospitable Kutch region have developed an interesting system of procuring potable sweetwater, even in an area where rainwater is scarce and groundwater is saline. They know that density of sweetwater is less than that of saline water and, hence, it is theoretically possible to keep the harvested sweet rainwater stored in a way that it will continue to float over the denser saline water. With this knowledge, they have developed precisely such a system, locally called *virda*, which is essentially like a well in a tank.

In dry areas of Rajasthan, people have traditionally practised conjunctive use of surface water and groundwater (*see box: Jodhpur: providing an example*). They invariably built structures like wells and stepwells — wells with a flight of stairs leading down to the water — below tanks and other types of water storage structures. Thus, when the tank water dried up, people could at least harvest clean groundwater to meet their drinking water needs. In other places, people would make wells in the tank bed from which they would collect groundwater for drinking. In many places, the surface runoff collected in the tank would not be used for drinking if clean groundwater was available from wells and stepwells. Rajasthan also has an old tradition of using rooftops as a catchment area to collect rainwater. In the town of Phalodi, if one household does not want to collect water from its rooftop, the neighbours borrow the roof to collect water for their purposes.

In areas where land is not a limiting factor, people have even developed customised rainwater harvesting structures called *kundis*. These amazing structures — apparently unique to the region — dot the landscape of Churu district in the Thar desert. *Kundis* are artificial wells which store runoff from an artificially prepared catchment surrounding them so that rainwater that falls on the catchment rapidly runs into the well and gets stored. They can be made anywhere if adequate land

Ladakhi streams — fed by glacier melt — have lots of water in the evening but nothing in the morning. Villagers store water in zings for irrigation in the morning

ANIL AGARWAL / CSE

A hundred mm of annual rainfall, common in the driest parts of Thar, if harvested by a *kundi* (artificial well) over one-ha of land, can provide one million litre of water annually — catering to 180-270 families

ANIL AGARWAL / CSE

Rain on the roof: residents of Phalodi even borrow their neighbour's roofs to collect the nectar from the heavens

is available. Their potential can be understood by the following fact: If an area receives only 100 mm of rainfall — which would make it an extremely arid environment — this rain harvested over one ha of land would provide one million litre (l) of water a year. As a family of five would not need more than 10-15 l a day for drinking and cooking — or 3,650-5,475 l a year — 180-270 families could meet their most critical water needs by building a one-ha *kundi*. ■

B. Management: of the people, by the people

Elaborate community-based water management systems, including ingenious property rights systems, have been in vogue in the country for ages

Water harvesting systems are fragile creations. They have to be continuously monitored, maintained and repaired. Even more difficult is sharing the scarce water amongst its consumers, particularly farmers. Popular ingenuity has found a way out even here: Across the country, people have devised a variety of property rights systems to share water and to maintain their water harvesting networks.

Himalaya and the north-east: right methods

To ensure equity in distribution of the scarce water, villagers in Ladakh elect a water official every year, known as *churpun*. This is done at the start of each agricultural season. The *churpun* ensures that each farmer gets adequate water in proportion to the area of land he owns without leaving any field unirrigated. Hence, disputes over the use of water are very rare. Canals are repaired by community effort. The position of *churpun* rotates amongst all households to ensure that no household monopolises this critical post.

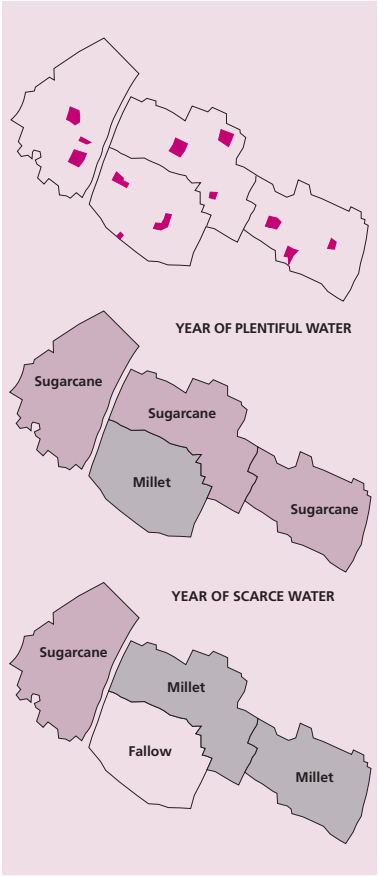
Villagers in Nagaland have also developed a variety of practices in order to share the available water for their terraced rice plots. While water sources are common property, land is a private acquisition. There are cases where water is transported over channels several kilometres long to reach crop-fields. In some Naga villages, local chiefs stand on a rock on a particular day in the months of May, June and July, and exhort villagers to offer prayers for good water and to clean the traditional water sources. Among the Angamis, Chakhesangs and Zeliang tribes, traditional water rights are held very rigidly by individuals, clans or *khels* (villages). In Khonoma village of Kohima district, for instance, the person whose field is closest to the water source is responsible for conserving the source. But the individual whose field is at the bottom of the canal is its owner; he\she has a major share of water and also regulates the flow of the water. He\she is also responsible for keeping the canal clean. While every one has the right to take water from the stream, nobody can take more than the demarcated share.

In Kikruma, a Chakhesang village located in Phek district, a

In some Naga villages, local chiefs stand on a rock on a particular day in the months of May, June and July, and exhort villagers to offer prayers for good water and to clean the traditional water sources

curious combination of water rights is in vogue. If a spring exists on a particular terrace which is not yet cultivated, the person below it is entitled to use it to develop his terrace. But in case the owner of the uncultivated terrace decides to develop his terrace at some later date, then the two will share the water equally. In general, the rights over runoff between different terraces is respected. The person at the top end of the terrace cannot harness what is legitimately the runoff right of those below. The maintenance of all channels and catchment areas of ponds is done once every year, usually before the onset of the monsoon. The responsibility of mobilising people to clean the channels rests with the last person tapping the channel, locally referred to as the *neipu*, which literally means the lord.

Inhabitants of the central Himalayan villages of Uttar Pradesh have adopted a simple device to avoid excess water being drawn by a channel at the head, thereby leaving less water for downstream users. A small boulder is placed at the mouth of each turnout. The size of the stone at successive water turnouts gets progressively smaller. Some measure of equity is thus ensured in water distribution. Water distribution in Ladyura village, for instance, is carried out by an irrigation committee which has 10 members, including a *chowkidar* (guard). Many non-elected members who are familiar with water distribution arrangements are co-opted as members. Major decisions are taken in a general body meeting which is open to all residents of the village. There is a mechanism to resolve disputes, under which the irrigation committee members of the upstream and downstream villages sharing the same channel meet to discuss the matter.



Water equity: In Maharashtra's Dhule and Nasik districts, villagers divide the cultivated land into* phads*. Every landowner has a piece of land in each* phad*. In a year of plentiful water, the community grows water-consuming sugarcane in three and water-efficient millet in one. In a year of scarce water, it grows sugarcane in one, millet in two and keeps one fallow

Maharashtra's *phad* system

The community-managed *phad* irrigation system, prevalent in Dhule and Nasik districts of north-western Maharashtra, probably came into existence some 300-400 years ago. A series of *bandharas* (dams) were built on the local rivers to divert water. In the *phad* system, variations in water availability from one year to another were managed by demarcating the command area into two categories: one with assured and another with unassured irrigation. In the years of good rain, the unassured area, which is invariably at the tail-end, also gets irrigation benefits.

Only one crop can be grown in one *phad;* the variety of crops to be grown in different *phads* is decided by an assembly of irrigators, depending on water availability. Crops are rotated among the *phads* so that over a period of two to three years every *phad* gets to grow sugarcane, the main cash crop. In Daterti village, for instance, the total cultivated land is divided into four *phads* (*see figure)*. Every landowner has a plot of land in each of the four *phads.* In a year of plentiful water the community may decide to grow sugarcane in three and millet in one. Conversely, in a year which has seen an average rainfall, the farmers may grow two *phads* of sugarcane and two of millet. In a bad year, the community may allow sugarcane in only one, grow millet in two and even keep one fallow. ■

Tamil Nadu: the two-tier wonder

In Tamil Nadu, which has a profusion of tanks, local irrigation institutions have evolved to develop a common code for maintenance, water-sharing and resolution of conflicts. The organisational structure operates, firstly, at a supervisory level as an enforcing authority, and, secondly, at a more menial level involving hard labour. The first level of officials is called *nattamaikar* (a group of persons representing the entire village) or *kavaimaniyam* (generally one person). While the *kavaimaniyam* is an irrigation functionary concerned exclusively with organising maintenance work, *nattamaikar* organises irrigation-related activities as well as other village functions such as temple festivals.

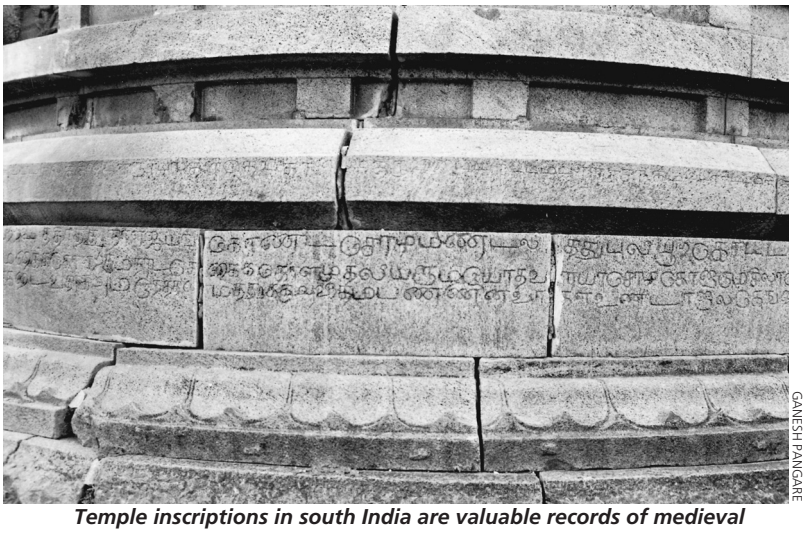
The *nattamai* and *kavaimaniyam* are assisted by irrigation workers called *neerkatti*, whose major responsibilities are to inspect the inlet channels during monsoon months, and to inform the *nattamaikar* or *kavaimaniyam* about breaches or illegal tapping of water by upstream farmers. The *neerkattis* also watch the bunds and surplus weirs, particularly during floods, irrigate lands as per the directions of the *kavaimaniyam* or *nattamaikar*, and protect the crop from cattle. The number of *neerkattis* varies from one to 10 depending upon the size of the command area. They are paid in kind every season by the farmers of the concerned tank command. Generally, wages are pooled on the basis of the command area cultivated, and shared equally among the irrigation workers.

The *nattamai* or *kavaimaniyam* generally call a meeting of the landholders in the command area as soon as a tank starts receiving water through its feeder channels. *Neerkattis* announce the meeting by beating drums. The meeting decides when to start the maintenance work and the contribution of labour by each landholder. If a landholder fails to contribute his labour, he must provide a substitute with hired labour, failing which he is liable to be fined. In some tanks, the *kavaimaniyam* maintains a record on the extent of labour involved in maintenance work.

People in central Himalayan villages of Uttar Pradesh place stones of varying sizes at the turnouts in the water they use, thus ensuring some measure of equity in water distribution

C. The State's non-bureaucratic role of encouraging the people

Indian rulers rarely built water harvesting structures themselves. They, however, encouraged their subjects to build them through fiscal incentives. A revival is possible today only if India returns to a community-based system of natural resource management



GANESH PANGARE

Temple inscriptions in south India are valuable records of medieval irrigation works

Pre-colonial roots

When the British disembarked on the Indian shores, they saw a land extremely rich, highly urbanised and intensely literate, with a flourishing tradition of arts, crafts and literature. The wealth of the land came from its internal resource mobilisation. The surplus generated in the villages not only supported the villages themselves, but also the cities and towns of the country. Over the centuries, Indians had learnt to use their land-water-vegetation resources in an intelligent and sustainable manner. The resource base around each village had been transformed into a complex agro-ecosystem of croplands, grazing lands (grasslands), and forest and tree lands, thus constituting an interactive multi-componential biological system that responded not only to the region's sharp seasonal rhythms, but also reduced risk by keeping the social and economic impact of rainfall variations down to a minimum. Due to the seasonal nature of rains, the people learnt to store the rainwater or the streamwater that flowed past during the monsoon season, in their own villages. When the British came, there were already thousands of water storage tanks in use across the country.

The Indian rulers preceding the British did not boast of irrigation bureaucracies or public works departments to create these structures. Referring to Rajasthan's Thar desert, traditional knowledge expert Komal Kothari says, "While collecting information from some 600 villages, I found that the state, the *jagirdar* (landowner) or anybody who had anything to do with revenue collection did not create any water body for the people. All water bodies constructed by the erstwhile kings, *jagirdars*, chiefs and chieftains were reserved for their personal use. The people largely had to fend for themselves." Though the role of the state varied from one region to another, it was nonetheless true that the rulers rarely built irrigation structures themselves. The massive Pichola lake in the city of Udaipur, for instance, was built by nomadic gypsies. However, the rulers did play an important role in encouraging people to build water harvesting structures.

The Vijayanagar empire

The famous Vijayanagar kings of south India (1336-1564 AD), for instance, placed great importance on developing irrigation facilities for agricultural improvement. Emperor Krishnadeva Raya (1509-1530), the greatest of the Vijayanagar rulers, once pointed out that the extent of a state is the root cause of its prosperity. Conversely, if the state was small, its prosperity will increase only when tanks and irrigation canals were constructed and favour was shown to poor cultivators in matters of taxation and services. The Vijayanagar kings, therefore, constructed irrigation tanks and canals themselves, though more rarely. But, more importantly, they encouraged private initiative in irrigation development in different ways.

In those days, land tax, which was collected in kind in the form of one-sixth of the produce, was an important source of revenue for Indian rulers. Thus, the rulers' fortunes depended

Sacred ways

On irrigation management initiated by temples

A pivotal role in irrigation management was played by temples. The famous temple of Kalahasti near Tirupati in Andhra Pradesh, for instance, used the endowments from its devotees to excavate irrigation channels and to reclaim temple lands. A Kalahasti inscription dating back to 1540 states: "Virappanar Ayyar deposited (with the treasury of the gods at Kalahasti) 1,306 *pon*, which was to be invested in the new settlements of Muttayammansamudram... with a view to bring the lands under cultivation (and) the lands of Lakkusetipuram are to be irrigated and brought under the plough with the help of the waters of Virasamudaram lake (which will) be repaired and maintained by investing 1,006 *pon* of the amount deposited." It made good economic sense for the temples to invest in irrigation. Getting a regular share in the production from the irrigated lands meant that they had a regular income. Temples were sometimes also granted tax-free land by the state; temple officials then leased these lands for reclamation and cultivation.

The Vijayanagar kings made *dasavanda* or *kattu kodage* grants — tax-free land grants — to individuals or institutions which undertook to build water harvesting systems

on agriculture. The state, therefore, had a vested interest in encouraging private initiative to develop irrigation systems. The Vijayanagar kings would make *dasavanda* or *kattu kodage* grants to individuals or institutions which undertook such works. The enterprising person would be granted a piece of tax-free land watered by the tank, canal or well which he/she excavated. The extent of the grant varied with the importance of the work. Thus, when one Harinideva Vodeyar constructed a tank in Mysore district, he was given a grant by emperor Deva Raya II (1423-1446); Vodeyar received a second grant when he enlarged the tank.

Jubalpur's Rani Talab: testimony to the wisdom of tribal Gond rulers who encouraged water harvesting systems

Dasavanda grants were made not just by the kings. A record of 1497 in the present Chittoor district registers a *kattu kodage* grant of land at Gundalahalli, made by the *sthanika* (manager) of a temple to one Narasimhadeva for digging a tank in the village belonging to the Kadiri Lakshminarsimha temple and for bringing the surrounding lands under cultivation.

Great religious merit was also attached to the maintenance and repair of irrigation works by the Vijayanagar kings. An inscription dating to 1413 states: "A ruined family, a breached tank or pond, a fallen kingdom, whomsoever restores, or repairs a damaged temple, acquires merit four-fold of that which accrued from them at first."

Early British observers were full of praise for the Vijayanagar irrigation works they saw. C S Crole, author of *The Manual of Chengleput District* (1879), said: *"Almost every catchment basin, however small, still bears traces of having been bunded across and in many instances this was done in order to secure a crop of paddy on a few acres of stony ungenerous soil, to which all the fostering care of the British administration has failed to induce cultivation to return. Large and more expensive projects were not neglected. Even some of them bear witness to the enlightenment of those Hindu kings, while the absence of scientific instruments in those remote times compels the astonishment of the beholder."*

Colonel Thomas Munro (the governor of Madras in 1820), noting the irrigation system in the area around Vijayanagar, said: *"To attempt the construction of new tanks is perhaps a more hopeless experiment than the repair of those which have been filled up (through siltation), for there is scarcely any place where a tank can be made to advantage that has not been applied to this purpose by the inhabitants."*

The Gond kingdom

The tribal Gond kings, who were great empire builders — by the 9th century AD, the whole of the eastern section of Central Provinces had come under Gond influence and was known as Gondwana (forest of the Gonds), from which is derived the name of Gondwanaland, the ancient geological continent — followed a similar practice of encouraging water harvesting methods. Ruins of old irrigation works dot the pre-colonial states of Patna and Sambalpur (both now in Orissa).

In the Gond empire, building of reservoirs for irrigation was the foremost duty of a village chief. Though the Gonds had a strong central government, each village was independent in its economy and governance. The village was primarily a settlement of peasants, and its assembly an association of cultivators. Its prosperity rested on proper management of land and water resources. Repairs of channels, embankments and distributaries were immediately taken up after the first rainfall. To anyone who constructed a tank, the Gond kings gave a grant of revenue-free land lying below it. Rent-free land was given to the *kodas*, a class of people who were experts in excavating water reservoirs and who looked after the maintenance of irrigation works; such land grants were known as *sagar rakshya jagit*. Agricultural prosperity increased under the Gond rulers, and great works like the Rani Talab near Jubalpur remain to this day as monuments to their rule.

British rule: seeds of disruption

British rule, unfortunately, laid this enormous heritage to waste. In their desire to rule, administer and maximise their revenues from this rich land, the British steadily impoverished the rural communities, leading to the destruction of their resource management systems, including the water management structures that had emerged over the centuries.

How the seeds were sown

Early British observers like Charles Metcalfe and Henry Maine had described India as a largely happy land of 'village republics'. What this meant, says historian Dharampal, is "that the 'village', to an extent, had all the semblance of the State; it controlled revenue and exercised authority within its sphere... The basic element of this 'village republic' was the authority it wielded, the resources it controlled, and dispensed, and the manner of such resource utilisation... Indian society and polity had basically been organised according to non-centralist concepts... That the annual exchequer receipts of Mughal emperor Jahangir did not amount to more than five per cent of the computed revenue of his empire, and that of (later Emperor) Aurangzeb with all his zeal for maximising such receipts, did not ever exceed 20 per cent, is symptomatic of the concepts and arrangements which governed Indian polity... there is voluminous data scattered in the British records themselves which confirm the view, that in terms of the basic expenses, both education and medical care, the expenses of the local police, and the maintenance of irrigation facilities, had primary claims on revenue..."

India's colonial rulers drained the revenue they collected out of the land and the country, leaving behind a devastated natural resource management system

The British tried to take remedial measures when they realised their mistake, but they failed to comprehend the strength of the indigenous system completely. As a result, the measures they took also failed

Dharampal points out that data collected by the British in the 1770s and 1780s from Bengal and Bihar showed that revenues of these areas were divided into several categories. The '*khalsa*' were those sources whose revenue was received in the exchequer of the ruling authority. Two of the other categories which probably accounted for about 80 per cent of the computed revenue of an area were termed as '*chakeran zemin*' and '*bazee zemin*'. The former implied such recipients of revenue who were engaged in administrative, economic and accounting

Minor irrigation works like* bandharas *in Maharashtra went out of fashion with the British rule

activities and were remunerated by assignments of revenue. The latter meant those individuals, groups and institutions which, according to the British, were in receipt of what were termed "religious and charitable allowances".

Assignments under *bazee zemin* were quite high. In Bengal, the British noted that "almost one half of the province is held upon free tenure" under the *bazee zemin* category. In many districts of Bengal and Bihar there were as many as 30,000 to 36,000 recipients per district. Even after 1750-1800, the period during which the British took control of south India, the situation in Madras presidency was not much different. As late as 1801, over 35 per cent of the total cultivated land in the present Rayalseema area and the district of Bellary came under the category of revenue-free assignments. Says Dharampal, "What was true of Bengal, Bihar and the Madras presidencies applied equally to other areas in India, whether in the areas of the Bombay presidency, or of Punjab, or in the Rajasthan states."

By about 1800, a very large percentage of these revenue assignments had been altogether dispossessed, reducing their beneficiaries to penury. Most of the remaining had their assignments greatly reduced so that they could no longer perform the educational, water management or other functions that they were expected to undertake. It was the task of Thomas Munro to reduce revenue-free assignments in the ceded districts to a mere five per cent of the total cultivated land. The revenue thus collected was drained out of the land and the country, leaving behind a devastated natural resource management system. With the destruction of the indigenous financial system, community property slowly became nobody's property.

Furthermore, what the colonial rulers could not own or earn money from, they neglected. As Arthur Cotton, the pioneer of modern irrigation in India, himself noted in 1874 about local water harvesting systems: "*There are a multitude of old native works in various parts of India... These are noble works, and show both boldness and engineering talent. They have stood for hundreds of years. When I first arrived in India, the contempt with which the natives justly spoke of us on account of this neglect of material improvements was very striking; they used to say we were a kind of civilised savages, wonderfully expert about fighting but so inferior to their great men that we would not even keep in repair the works they had constructed, much less even imitate them in extending the system.*"

The cancer spreads

The British tried to take remedial measures when they realised their mistake, but they failed to comprehend the strength of the indigenous system completely. As a result, the measures they undertook also failed. Firstly, they created irrigation and public works bureaucracies which were supposed to own and manage the neglected water harvesting systems. When these technocracies failed to revive these systems, the British authorities in Madras presidency, in the mistaken belief that local communities would undertake voluntary labour to maintain the tanks as a tradition, enacted the notorious Madras Compulsory Labour Act of 1858. In Bengal, as William Willcocks pointed out (*see box: The legacy of Bill Willcocks*), the British even failed to understand the technological nature of the indigenous irrigation system.

With the progress of British rule, there was also a gradual shift in emphasis from minor irrigation works like tanks, wells, *bandharas* (dams) and small river channels to large dams and canals commanding extensive areas. Indian rulers, on the other hand, continued to build and maintain tanks in states which had remained free from British rule. In contrast to the erstwhile Madras presidency area, there is evidence that tank irrigation in the former Hyderabad state was of more recent origin. Under the Nizams, from 4,500 ha in 1895-96, the public works department (PWD) of the Hyderabad state reached around 45,000 ha of tank-irrigated area around the turn of the century, and between 324,000 ha and 364,500 ha some 40 years later. The fact that the PWD of Hyderabad expanded the tank-irrigated area while the British government in Madras presidency did not do so, indicates that the intensity of tank irrigation in different areas was greatly influenced by the policies of their respective governments.

Even worse, the British, in their bid to rule, educated an entire class of Indians which no longer appreciated or understood India. They were, in fact, so successful that when India became independent, the leaders of modern India also turned their backs on these systems. Indians invested almost exclusively in mega-irrigation projects, greatly influenced by the technological dreams of socialist countries like the Soviet Union.

Over time, downfall in community self-management, bureaucratic intervention in village affairs and unchecked technological changes have further eroded the traditional water harvesting systems

With about five-10 per cent of India's land area set aside for rainwater collection, most of its irrigation and household water needs can be met

A persistent downslide

Over time, other changes have taken place in several parts of India which have further eroded the traditional water harvesting systems. Overall, there has been a downfall in community self-management as bureaucratic intervention in village affairs has been steadily encouraged by India's political leaders. Technological changes like the introduction of tubewells means that richer farmers in the command area of a tank, who can install these tubewells, no longer have an interest in cooperating with the rest of the community in managing the tanks. The future of the *phad* system in Maharashtra, for instance, is now uncertain. Firstly, the government has, in its usual unimaginative manner, built reservoirs upstream to utilise the available river waters, thus affecting the post-monsoon flows downstream, where the *bandharas* feeding the *phads* with water were built. Secondly, a sugar factory has come up in the area, increasing the demand for sugarcane, a water-intensive crop.

Many central and southern Indian cities like Hyderabad, Chennai (Madras) and Bangalore grew up around traditional water harvesting systems. But in these urban areas too, these systems have either disappeared because of pressure from real estate lobbies or have become heavily polluted. As a result, traditional water harvesting systems continue to play an important role largely in remote areas where the reach of water bureaucracies remains weak, as in many Himalayan states.

Promising potential

A revival of these systems, however, is in the offing. Their potential is once again being recognised and debated over. This is because the large water supply systems built around mega-dams have proved to be extremely capital-intensive, with long gestation periods, and rather low returns in terms of increased crop productivity, largely because the water supplied by these systems is determined more by bureaucracies controlling these systems rather than the farmers. Irrigation efficiency of tubewells, since they are farmer-controlled, has been much better. But the rapid increase in tubewells in dry areas, without the supplemental groundwater recharge that used to be ensured by traditional water harvesting systems, is leading to a depletion of groundwater aquifers and will become a severe problem in the years to come. Rainwater harvesting systems, on the other hand, require small sums of money, a large part of which can come from local communities, thus avoiding an undue drain on the state exchequer; they can be built within months (instead of years like large dams); they will be under the control of farmers themselves; and, they can be used conjunctively with tubewells as they can recharge the groundwater aquifers.

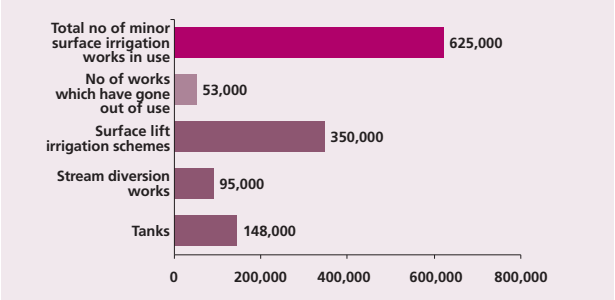
In terms of the water they can store, their potential is stupendous. If five per cent of India's land area — about 15 mha — was used to store water at an average depth of five metre, India would be able to get 37.5-75 mha-metre of water annually, depending on the rainwater collection efficiency ranging from 50 per cent to 100 per cent.

There is, theoretically speaking, no village in India which cannot meet its drinking and cooking water needs through rainwater harvesting. If an average individual needs 2.5 l per day of water for cooking and drinking, a billion people India's expected population by the turn of the century, will need about 2.5 billion l per day or 912.5 billion l per year. If rain was harvested over a mere 83,000 ha or 830 sq km every year (the Union territory of Delhi alone is 1,483 sq km), clean drinking and cooking water could be obtained for the country's entire population. And if the nationwide supply of water was stipulated at 100 l per person per day, the norm used in many urban areas, then too all that we would need is one per cent of India's land area to set aside for rainwater harvesting. If the rainwater collection efficiency was only 50 per cent, the total land requirement would not be more than two per cent of India's land area. Given the already horrendous and still growing pollution of India's rivers with industrial contaminants and fertiliser and pesticide runoffs from farmlands, Indians may soon have no other option but to capture raindrops as a clean water source. The technological options to clean the raw river water from contaminants will probably be impossible for India to afford.

Thus, with about five-10 per cent of India's land area set aside for rainwater collection, most of India's irrigation and household water needs can be met. But a decentralised system of water management will demand a community-based system of natural resource management. Unfortunately, most laws that govern India's land, water and forests even today are the same as those formulated by the British. The Indian government has the unique honour of trying to deal with 21st century problems of environmental management with archaic 19th century laws and bureaucracies of a colonial ruler. The key question today is will Indian governments continue to manage the environment through their gilded bureaucracies, or will they democratise its control and leave its management to rural communities? ■

Use and disuse: in figures

The 1986-87 census of minor irrigation works revealed that the 625,000 traditional works still in use had an irrigation potential of 7.6 million ha



Down To Earth will carry more on traditional water harvesting systems in its forthcoming issues. Readers are invited to send in their comments and contributions. Those interested in purchasing a copy of the **Fourth Citizens' Report** *may write to S Banerji, Sales Manager, Centre for Science and Environment, 41, Tughlakabad Institutional Area, New Delhi - 110 062*

The flush toilet is ecologically mindless

Think about it.

SUNITA NARAIN

WHILE attending the Stockholm Water Symposium a few years ago, my colleague, Anil Agarwal, and I were invited to a banquet by the king of Sweden. But instead of dining in splendour we were checking out toilets in some remote parts of the city. I was not too convinced of our mission. We opened the hatch of "alternative" toilets bins, where the faecal matter is stored before composting. We were regaled with information about how urine could be separated in the toilet and used directly for agriculture. Our friend, Uno Winblad, toilet crazy like Anil, then took us to supermarkets in Stockholm city where there were a range of toilets — from water-saving to electric and of course, urine separating toilets. Anil, who hated shops, was delighted. And I began to understand the links.

The flush toilet and the sewage system — which I always believed embodied personal hygiene and environmental cleanliness — are a part of the environmental problem and not the solution. I began to understand from our research that this technology is quite simply ecologically mindless.

Consider the large amount of clean water that is used to carry even a small quantity of human excreta. In India, flushes are designed to be particularly water-wasteful. So with each flush, over 10 litres of clean water goes down the drain. We

PREETI SINGH / CSE

build huge dams and irrigation systems to bring water to urban areas. This water which is flushed down the toilet goes into an equally expensive sewage system, all to end up polluting more water — invariably our rivers and ponds. Most of our rivers are today dead because of the domestic sewage load from cities. We have turned our surface water systems into open sewage drains.

This heavy use of surface water is leading to growing conflicts between urban and rural users and also to overexploitation. Moreover, the discharge of domestic sewage is leading to heavy pollution of rivers and urban groundwater aquifers.

The present strategy is to invest in huge river clean up programmes like the Ganga Action Plan, the Yamuna Action Plan or the National River Action Plan to treat sewage. These expensive river action programmes are sanitary engineers' dreams. The aim is to divert sewage, which earlier flowed directly into the river, to a treatment facility. This sewage, incidentally, comes from the flush toilets of the rich, not the poor.

This is what Anil called the political economy of defecation. The more water you use, the more investment is needed to clean it up.

The *political economy* of sewer systems is simply atrocious for developing countries. Hardly any poor city is able to recover its investments in sewer systems. As a result, the users of these sewer systems get a subsidy. But almost all users in poor cities are the rich. Thus, sewers only lead to a subsidy for the rich to excrete in convenience. The poor always remain the 'unserved' in this waste disposal paradigm. In addition, the government has to invest in sewage treatment plants whose costs are again rarely recovered from the rich users of flush toilets.

Sewers cost the earth

It is virtually impossible for governments to catch up with the targets of building sewage treatment plants. Government programmes chase targets hopelessly and remain miles behind the volume of sewage being generated. In a rapidly urbanising situation, the city would soon outgrow the sewage treatment capacity created at a high cost. Further investments would be needed all over again.

Take Delhi, as a typical instance. Yamuna is Delhi's main sewage drain. Yamuna enters Delhi at Wazirabad — where the city draws its water supply — and after this an estimated 1,800 million litres per day (mld) of untreated sewage flows through 18 drains into the river. In the last four decades, the total sewage output has increased rapidly. Untreated sewage has grown even faster. In 1999, the Central Pollution Control Board estimated that Delhi produces over 2,547 mld of sewage of which only 885 mld is collected through the sewage network for treatment and the bulk — over 75 per cent flows into stormwater drains and then into the river. By late 2000, treated sewage had increased to 1,333 mld as had the quantity of sewage — still over 50 per cent of the city sewage was dumped into the river. By 2005, Delhi plans to triple its present sewage treatment capacity at a cost of Rs 750 crore. But this will still be less than what is needed.

Understand the political economy of defecation

Sewer systems totally destroy nature's nutrient cycle

Paradoxical chase

It is an ironic situation. Even if Delhi builds all the sewage treatment plants, it will still not have the sewage to treat. Why? The city's sewage drains are choked and silted. The government admits that the present capacity of the sewage treatment plants is not being utilised and when it builds new treatment facilities, sewage never reaches these plants.

On the other hand, sewage from these choked and broken lines is diverted to functioning lines and, as a result, the treatment plants at the end of these lines are overloaded leading to untreated sewage flowing into the river. While some plants are overloaded, others are underutilised. The bill to refurbish the sewers is around Rs 500 crore, according to the government. Over and above this is the capital cost of the new sewage treatment plants.

Moreover, this is the cost of maintaining and running sewage plants and ensuring that the released effluent meets quality standards. Even if the government were to bear the full capital costs of sewage treatment plants, few urban municipalities have the financial resources to bear the expensive operating costs. As a result, sewage treatment plants, even when built, often lie idle.

In urban areas, drinking water is a small component of the total water use. It is sewage and other waste disposal needs that require maximum water input. This huge demand for water for our cities comes at very high political cost as conflicts between urban and rural users for water are reaching flashpoint.

A tale of two cities

The water culture of people is an important indicator of their level of civilization. Take the two ancient cities, Rome and the town of Edo, which grew into the mega-metropolis of Tokyo. The people of Rome brought their drinking water with the help of long aqueducts, which today are regarded as architectural marvels of the bygone Roman civilisation. But the people of Rome lived on the banks of the river Tiber. They didn't need to bring water from afar. Unfortunately, they did not know to dispose of their human wastes and like the modern Western civilisation they ended up polluting the river, thus being forced to go far in search of clean water. This makes Roman aqueducts not a symbol of intelligence but one of great environmental stupidity.

On the other hand, Edo, which too was situated on several streams, ensured that all its human wastes were collected and returned to the farmlands. Its neighbouring rivers remained clean and it tapped its water from them through an extensive piped water supply.

But today we are all children of Rome and not Edo. We have turned our backs to our waterbodies and if we don't have money to clean our mess, then we will have nothing but polluted waters.

Paying "full costs"

Worse, the political economy of defecation is such that no democratic government will accept the hard fact that it cannot "afford" to invest in modern sewage systems for its citizens. Instead, it continues to subsidise the users of these systems, in the name of the poor, who cannot afford these systems in the first place. The cost to build sewage treatment plants is externalised through these environmental programmes. The logical policy would be to accept the cost and then to impose differential pricing so that while the rich pay for the cost of the capital and resource intensive sewage and waste disposal technology, the poor pay for the cost of their disposal system, which is invariably unconnected to the sewerage system and hence low cost.

But this is easier said then done. The "socialist" framework in our country forces political leaders to keep water and waste pricing affordable for large sections of urban populations. In this situation, private investment also looks for an easy way out. Their answer is to invest in water services and leave the costly business of cleaning up the waste to government agencies.

In the meantime, the use of sewer systems would have totally destroyed the aquatic ecosystems in the developing world, posing enormous threats both to public health and aquatic biodiversity. In India, we don't even have to look a few years ahead. We already see the signs of this hydrocide. Literally, no small or medium river today is clean. Every river that passes through a city or a town becomes a stinking sewer.

Dirty sewers

Sewage systems are built to protect public health but badly managed sewers can become a serious health hazard. There can be serious outbreaks of waterborne diseases from:

- River pollution because of sewage outfalls;
- Groundwater contamination because of leaky sewer lines;
- Contamination of piped water supply systems because of leaky sewer lines leading to infiltration of pathogens into drinking water pipelines, especially when they do not have water, which is the case in many cities in developing countries as they cannot provide water round the clock; and,
- Sewage backflows because of badly maintained and blocked sewers or because of increasing use of non-biodegradable materials like plastic bags.

In the Indian city of Aligarh, sewer lines overflow all the time. A study conducted by the Aligarh Muslim University for the Centre for Science and Environment found that 49-70 per cent of the households, depending on different localities, complained of seasonal or permanent waterlogging due to overflowing sewage drains. As a result, people have raised the plinth of their houses to keep the sewage from flowing into their houses. This has resulted in a huge market for earth — as much as 1,000 cubic metres per day — supplied today by numerous villages around the city, which is destroying precious agricultural land.

All this makes water-borne sewerage a waste disposal paradigm that is extremely expensive because of its high

economic, environmental and public health costs. And as a result, it has very high political costs.

Going against the laws of nature

Sewer systems totally destroy nature's nutrient cycle in which nutrients collected from the land should be returned to the land. With the use of sewers, this "waste" gets dumped into our aquatic systems. Therefore, while nutrients in food come from agricultural lands, sewage systems dump the nutrients contained in human wastes into waterbodies. Over time, our agricultural lands get depleted of nutrients and need intensive artificial fertilisation. The lack of these micronutrients not only becomes a limiting factor in plant productivity but the resulting lack of these nutrients in human food becomes a threat to human health. By the early 1980s, Punjab had large tracts of land with zinc, manganese and iron deficiency. Ludhiana district, which records the highest yields of many crops, was also recording the highest deficiencies of micronutrients. Though scientists still have to figure out the health effects of consuming micronutrient-deficient foodgrains, scientists at the Postgraduate Institute of Medical Sciences in Chandigarh have found that consuming zinc-deficient foodgrains can lead to retarded growth, defective wound healing and carbohydrate intolerance.

Paradigm shift

Clearly we need to look for a cost-effective and non-sewerage paradigm of human waste disposal. The capital-intensive, material-intensive urbanisation process of the West works only for rich countries, not poor countries.

While our scientists think about going to the moon, the toilet is not in their vision at all. There is absolutely no thinking about the need to find environment-friendly sewage systems in our countries. We will need massive investments in R&D for non-sewerage alternatives. While investments in sewers run into billions of dollars every year despite all the problems they create, research investments in non-sewage alternatives hardly exist.

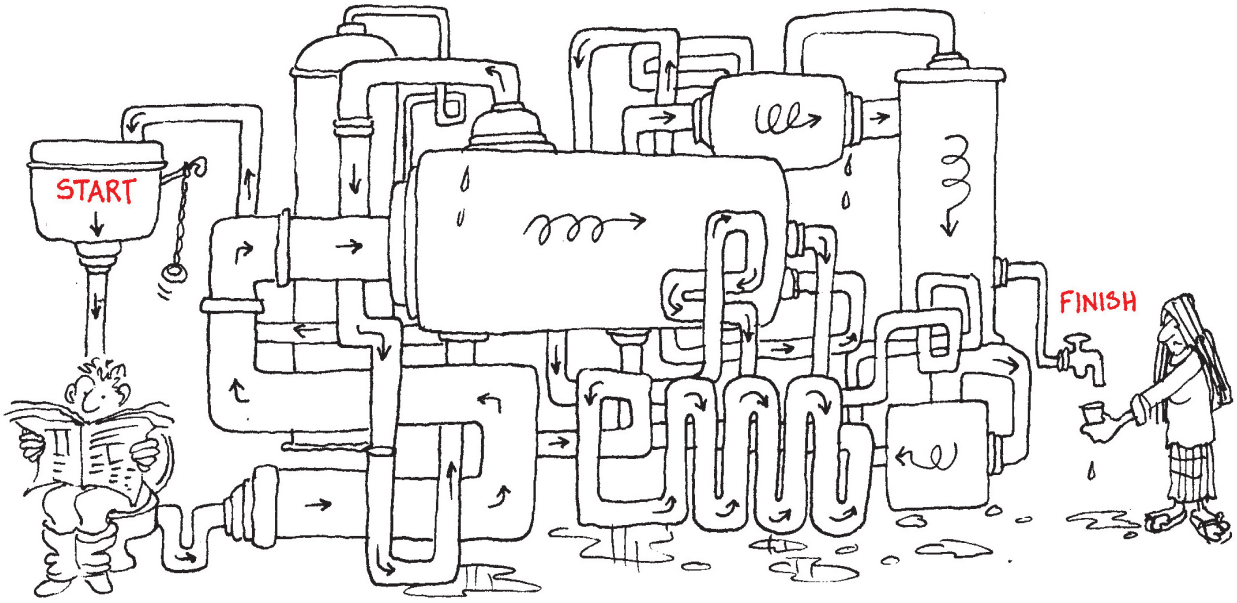
But who will ask for an alternative paradigm? The entrenched interests and mindsets of our sanitary engineers being what they are, there is no demand for change from this community. But change, we must.

In this context we need to learn from what is happening across the world. There is a growing concern for ecological sanitation and this is giving rise to innovations from the concept of sewer-less cities using new technological systems which use extremely low amounts of water or no water at all, and, in which all the wastewaters and the solid wastes are recycled.

These modern systems are built on the traditional science of recycling and composting human waste. But in a way that uses the best of modern science and technology to "sanitise" waste and match the convenience and public hygiene of the modern flush toilet.

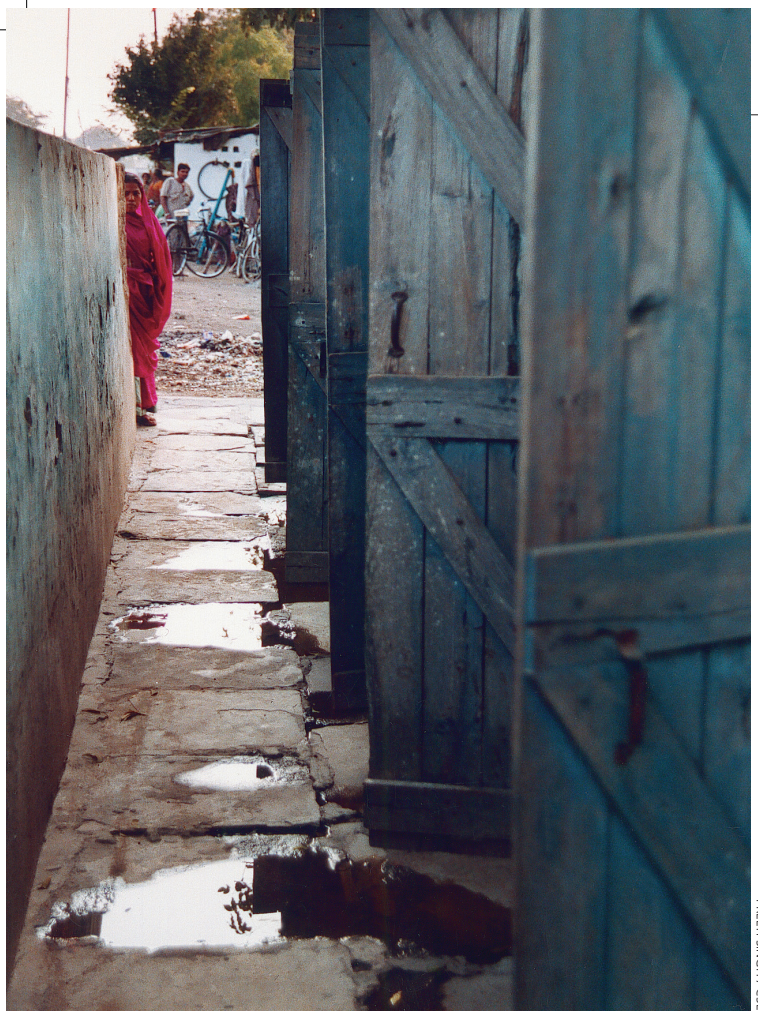
Therefore, ecological sanitation is a paradigm that we must explore in all earnestness. *But we must make sure that the new technologies take into account cultural constraints.* Otherwise they are unlikely to succeed.

The most important issue is that these "alternative" technologies must be for the rich and not just for the poor. If ecosanitation technologies are "cost effective" technologies to serve the "unserved" poor, these will only be an interim alternative, one to be discarded as soon as people become rich. We have to remember that it is the rich person's flush that is the biggest environmental culprit today.



ILLUSTRATIONS: RUSTAM VANIA

Sewers: a subsidy for the rich to excrete in convenience



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DROWNING

Sanitation for urban India means building flush toilets and linking them to sewer systems. But the price of chasing this dream is leading to an environmental catastrophe. MANOJ NADKARNI **analyses our flush and forget mindset**

"Don't flush." M K Malhotra, a resident of Delhi's Vasant Kunj, has put this instruction on his toilet. Six members of his family use this toilet at least three times a day and ten litres of water goes down the drain with every flush. In a water-scarce locality, Malhotra can hardly afford this basic sanitation practice. "In fact, it's a luxury," he says.

Malhotra's warning is apt. Flushing consumes maximum amount of water in an average urban household. An ever-increasing urban population — 25.8 million in 1901 to 285 million in 2001 — has thrown up two problems: shortage of water and sewage overload. Malhotra is still fortunate: more than 80 per cent people in rural India do not have access to toilets.

"Sanitation is more important than independence," Mahatma Gandhi once said. It is been 55 years since independence and sanitation is still a neglected sector in India. Sanitation is available to 48 per cent of urban and just 3.15 per cent of the rural population. As the Planning Commission pointed out in the Ninth Plan, "While the provision of drinking water to urban areas in the country has improved over the years, the provision of sewerage and drainage facilities has not received adequate attention."

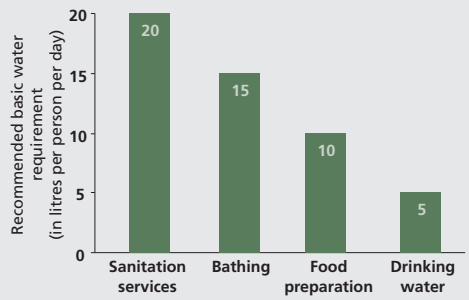
Health costs

Providing water and sanitation facilities may seem expensive, but the costs of not providing are much higher. In Karachi, Pakistan, for example, a study found that poor people living in areas without any sanitation or hygiene education spent six times more on medical care than people who lived in areas with access to sanitation and who had a basic knowledge of household hygiene. In India, rural people spend at least Rs 100 each year for the treatment of water/sanitation-related diseases. According to the government of India, this adds up to Rs 6,700 crore annually, which is just Rs 52 crore less than the annual budget of the Union health ministry's and more than the allocation for education.

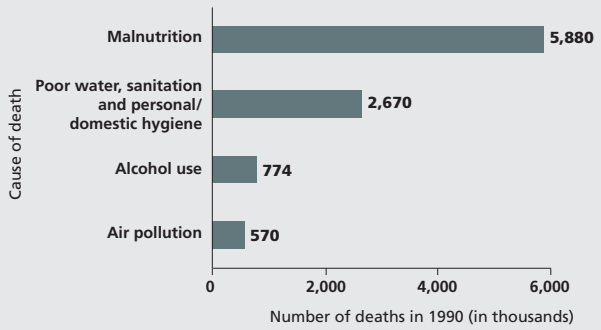
It is not as if these diseases appear out of nowhere. People contaminate the environment and they are in turn infected through the "pathogen cycle" (see flow chart: *Deadly web*). Breaking this cycle is the function of sanitation. In simplest terms, sanitation acts as a barrier between humans and disease causing agents. The barriers are generally physical, chemical or spatial. The flush toilets and sewage systems are supposed to

PARADOX OF A PARADIGM: lack of sanitation spawns outbreaks;

Sanitation is water intensive...



...and is the second-largest killer.



Sources: Peter H Gleick, The World's Water, 2000-2001, p11; Abstract Volume, First International Conference on Ecological Sanitation, November 5-8, 2001, p7;`Status of water supply and waste

IN HUMAN EXCRETA

provide all three: flushing physically carries pathogen-bearing faeces away from contact with us, the sewage system creates some space between the two, while chemical and other processes in treatment plants are used to destroy them.

Standard toilets and sewage systems are taken for granted in middle and upper class homes in urban India. The attitude is: flush and forget — out of sight and out of mind. However, what happens to the waste after the flush is pulled? After some treatment, it flows in our taps. Possibly, for middle and upper classes living urban environments with artificially low water charges, there is nothing wrong with it, especially in the short term. But when the whole picture is taken into account, the benign nature of sewage changes dramatically.

Urban sewage systems can be seen as a linear process. The act of flushing lets large amounts of water physically push excreta and diluted urine down and around the "s" seal of the toilet. Blackwater (wastewater which bears human excreta) and grey (wastewater from the bath, kitchens and sinks) are mixed when they leave a house. The pipe carrying this wastewater joins pipes of other houses or apartment blocks and empties into the municipal sewer. This relatively small diameter sewer joins other peripheral sewers and finally joins a large trunk sewage drain. More water is added to stop blocking of sewage lines. Water to transport is pumped and kept flowing. (But not too much water, since this would overwhelm the system.) These sewers keep the wastes flowing to a sewage treatment plant. This treatment involves removing the solids as sludge, getting rid of organic and inorganic pollutants, disinfecting it of pathogens and finally in some state of cleanliness, the treated water is released into the nearest river or sea. The solid sludge left is used either as landfill or as fertiliser. So far so good. At least on paper.

Overwhelmed by sewage

In reality things don't work so well. Firstly, only a small percentage of Indian towns and cities actually have sewage treatment plants. The Central Pollution Control Board points out that out of 22,900 million litres a day (MLD) generated as wastewater, only 5,900 MLD is treated — less than 3 per cent.

So where does the rest (untreated) with its load of dangerous pathogens go? Often untreated sewage is dumped straight into rivers or other surface bodies. The environmental and health costs are enormous: our rivers and our children are dying. This is because large amounts of water are being taken away from the rivers and used to carry excreta. The 'diluted' excreta is drained into rivers. Most Indian cities are based on river basins and use these rivers as sources for drinking water and waste disposal.

Sewage treatment is also expensive. The Mumbai-based Indira Gandhi Institute of Development Research (IGIDR) has estimated that to provide wastewater treatment in 10 large cities (population of 1.5 million and above) it would cost Rs 1,400-1,600 crore depending on the technology used for sewage management. The land requirement in these 10 cities would be 1,137 hectares. This estimate does not include the infrastructure, which needs to be in place as well as ongoing operating costs. Another assessment by the CPCB says that treating sewage for 23 metro cities would cost Rs 2,750 crore at 1994 prices.

No access

What is even more worrying is that a minority of Indians, who have access to sewers, cause water pollution. According to National Sample Survey Organisation's 54th round survey, 74 per cent of urban population use toilets, but only 22.5 per cent are connected to sewers and 35.2 per cent use septic tanks.

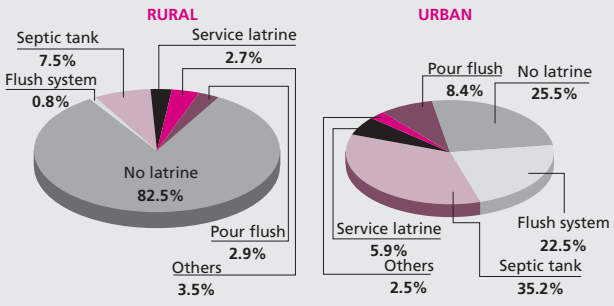
In Indian cities a large part of the population lives in slums and peri-urban area and these settlements quite often have no "legitimacy" and are not factored in any urban sewerage planning. Yet in a city like Mumbai, half of its nearly 12 million residents are either slum dwellers or homeless. They occupy six per cent of the city's land, living in cramped squatter areas with little or no access to sewage and sanitation facilities. When they are included, often under pressure from NGOs, the first thought is to build flush systems and sewerage, which proves to be economically unsuitable. In a slum, up to 500 people could share one toilet. Moreover, very little thought is given to their

access to flush toilets invites ecological catastrophe

Human waste is nutrient rich

City	Wastewater	Concentration		
		Nitrogen 30 ml/l	Phosphate 7.5 mg/l	Potassium 25 mg/l
Mumbai	2,456.0	73.7	18.4	61.4
Kolkata	1,432.2	43.0	10.7	35.8
Delhi	1,270.0	38.1	9.5	31.8
Pune	432.0	13.0	3.2	3.5
Hyderabad	373.3	11.2	2.8	9.3
Chennai	276.0	8.3	2.1	6.9

The urban-rural divide



water generation, collection, treatment and disposal in metrocities (1994-95), CPCB, August 1997, p32-33; Anon July 1999, Drinking water, sanitation and hygiene in India, NSSO, p40

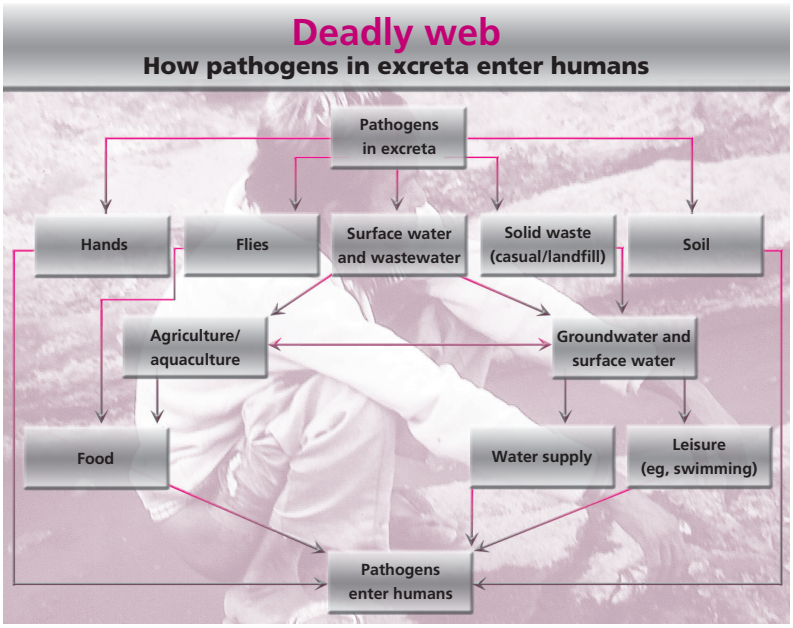
upkeep. For example, in Delhi the MCD is the implementing agency for low cost sanitation schemes including community toilet complexes. But these don't work most of the time.

Scavenging

The drive to do away with scavenging system — the practice in which toilets not connected to sewers are manually emptied and cleaned — was an opportunity to bring in fresh thinking into toilet designs keeping in mind Indian context. But this never happened. Rather, the government stuck to the flush type latrines. With the passing of the 1993 Employment of Manual Scavengers and Construction of Dry Latrines (Prohibition) Act, the conversion of the so-called dry latrines to water seal pour flush latrines got underway. Up to March 2000, Rs 1,339.98 crore had been spent on this scheme, states an appraisal report of the planning commission. Yet, less then eight per cent of the total recorded dry latrines were converted to sanitary ones till the first three years of the Ninth Plan. To meet this huge target of adopting water-intensive technology, the government has to dole out the required money. Funds will be required to not only set up infrastructure needed, but to maintain them, given the growing demand for flush toilets.

Then money will be needed to build sewage treatment facilities. Though industrial pollution in rivers often gets prominence, human sewage is the biggest threat: 80 per cent of pollution in Indian rivers is due to human sewage, says the Planning Commission. The Union ministry of environment and forests (MEF), in its Ninth Plan, fixed a target to set up sewage treatment facilities for 1,591 towns having a population over 20,000, in coordination with Union ministry of urban development and state governments. The question is where will the money come from?

The sewers in Delhi have lost 80 per cent of thier carrying capacity due to age and poor maintenance. This means that only 20 per cent of domestic wastewater is being treated, the rest flows directly into the Yamuna. In the case of major river pollution abatement activity like the Ganga Action Plan, only 13.7 per cent of the targeted sewage treatment capacity has been created.



GRAPHIC: SHRI KRISHAN

Source: Abstract Volume, First International Conference on Ecological Sanitation, November 5-8, 2001, p105

Constipated mindset

Already, the costs of treatment are not being met. An indication of this is the price of water. If all the water treatment were taken into account in a city like Delhi, the price of water would be Rs 4.61 per litre. Instead, the Delhi Jal Board is charging just Rs 1.99. Revenue generation is 43 per cent of production costs in Delhi. In Kolkata, it's at a ridiculous 14 per cent, in Nagpur, 48 per cent and for Pune, it is 49 per cent. This is just the cost of treating water to make it fit to drink; none of these figures are inclusive of the cost of treating sewage, before putting it into the rivers.

Another important constraint to service peri-urban areas is that lower-cost technologies usually require a much higher level of user involvement than conventional technology to function properly. Yet engineers, who traditionally play a major role in the formulation of sanitation projects, often have little training or regard for the social mechanics of projects, such as mobilising communities and involving future users, and have little patience for the sheer time it takes to address them.

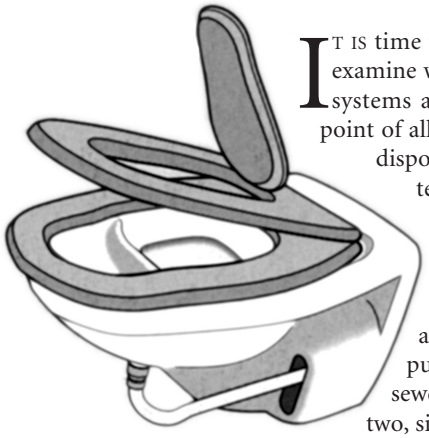
The Planning Commission points out what it calls the "vicious circle of circumstances" — due to economic non-viability of the urban sewage and sanitation, programmes have failed to cover all the population and due to insufficient funding, operation and maintenance have failed miserably. There has to be a paradigm shift in the way sanitation policies are formulated. The new approach would have to suit the social and geographical factors of the region and be environmentally and economically sustainable. But who will bell the cat?

PREETI SINGH / CSE

Sanitised or not, the writing is on the wall

NEW AGE APPROACH

We need to go back to the drawing board to reinvent a green toilet. If necessary, to go back to our past and find technological innovations that are sustainable and equitable. So that every Indian can have access to sanitation and still have clean water to drink. The alternatives to the flush toilets are emerging. These are beginnings of the new approach of sanitation — sewerless and less water intensive



IT IS time to go back to basics and examine what toilets and sewerage systems are supposed to do. The point of all these systems is the safe disposal of human waste matter. Flush toilets and sewerage transfer the problem elsewhere; they are complicated ways of spreading pathogens away from the user to the public at large. Toilets and sewerage can be split up into two, since there really is no logical connection between the two, just a historical one. The safe disposal of wastes can be undertaken in two ways:

Off-plot systems in which excreta are collected from houses and then transported away. This is what the modern sewerage system is. *On-plot systems* in which safe disposal of excreta takes place on or near the household.

If sewerage and flush toilets are considered indispensable, the way to reduce their environmental and financial impact is controlling how much water they waste. What options are available to reduce water use in sewage systems?

Back to nature

In the flush system, the water is used not just to clean the toilet bowl, but also to transport the excreta. A family of five who uses a water toilet contaminates more than 150 thousand litres of water to transport 250 litres of excrement in one year. We must recognise that:

- Water is a precious resource and should not be used to transport faeces.
- Waste should be managed as close as possible to its source.
- Faeces and urine are resources rather than waste products.

The first step is seeing our biological "waste" as resources. All organisms need nutrients to grow; plants get these nutrients from the soil. Sewage systems bypass the natural flow of nutrients back to the soil and instead dump these nutrients into water. On an average, a healthy person discharges 100 to 400 grammes of faecal matter and 1-1.31 kilogramme of urine per day, which has nitrogen, phosphate and potassium.

So with this first step, toilets can be seen as collection devices rather than methods of getting rid of wastes. The problem is cultural — a society is "civilised" if it has access to flush toilets; faeces and urine are used only by less developed ones. But if these cultural blinkers are thrown away, progress can be made towards solving the problem of polluted rivers and groundwater, waterborne diseases and the enormous cost of sewage treatment.

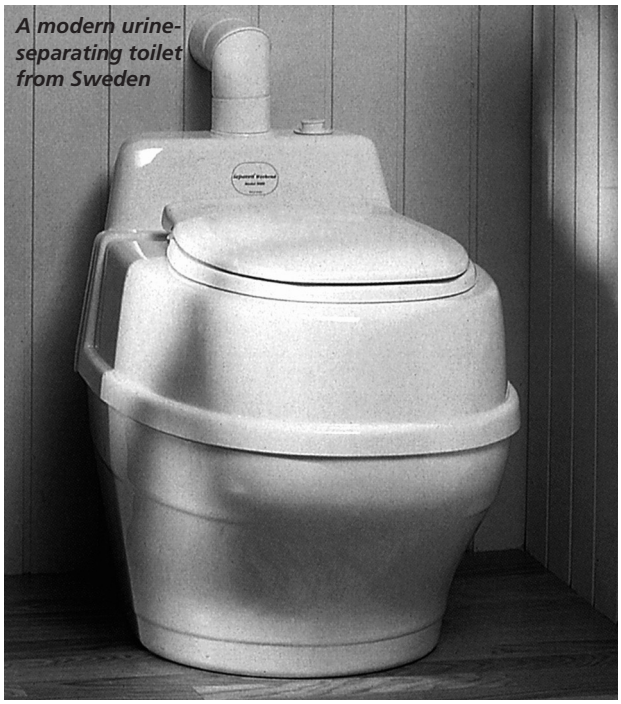
The second step is recognise that water is a precious resource and should not be used to transport faeces. And since we know excreta contains dangerous pathogens, it makes very little sense to dilute pathogens in water. Even if a small amount of pathogen-carrying material is mixed with a lot of pure water, the result is still a dangerous mixture. Unless treated properly, human waste is hazardous waste and "civilised" society puts it into drinking water sources.

The third basic principle is that waste should be managed as close as possible to its source. Ignoring this principle is one of the reasons centralised sewage systems are so unsustainable both financially and environmentally.

Sewerage tactics

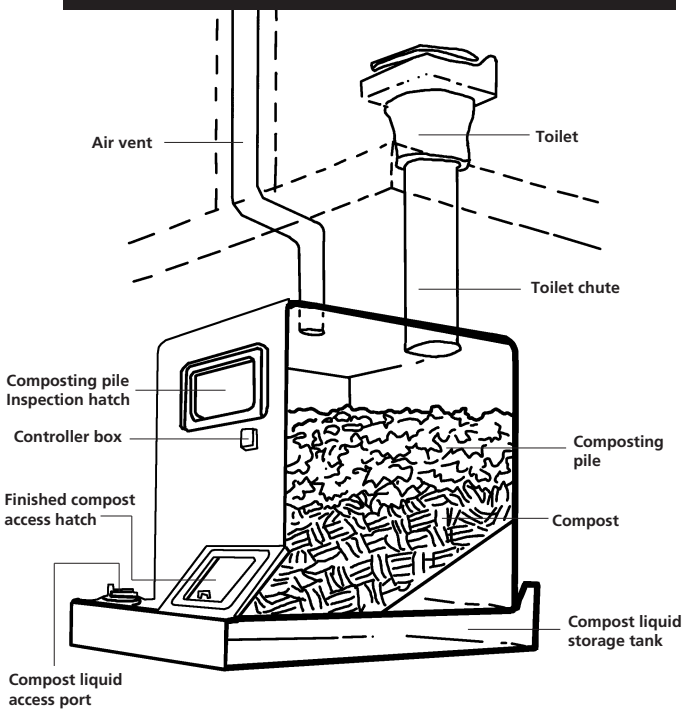
One way to do this would be change sewerage tactics. The condominial sewerage system was developed in Brazil as a low-cost option as they cost about 50-80 per cent less than standard systems. Households are connected to small-bore pipes rather than directly to sewers. These smaller pipes meet up and connect to the main municipal sewer. Smaller bore pipes need less water and at far lower pressure, making an immediate savings in the volume of water used to carry faeces.

Another possibility is decentralised effluent treatment. A



A modern urine-separating toilet from Sweden

THE CLIVUS MULTRUM COMPOSTING TOILET



block of houses or a housing colony can have its own sewage treatment plant. Again this means that compared to centralised systems, far less water is used, as wastes do not have to be transported very far. Treatment plants can be smaller in size since the volume of wastes they will deal with will be comparatively small. Any sludge produced is used locally as fertiliser.

A high-tech system is to do away with water-based sewerage and have vacuum-based sewer system like the one developed in Germany. If these can be coupled with vacuum toilets there is virtually no need of water. The outflows from toilets, kitchens, and baths are sucked by a local pump into a household vacuum station, from where they are sucked into a central treatment point. Vacuum sewer network can work up to a 4 km radius with one vacuum station. The collected sludge can then be conventionally treated or used in a biogas digester. However, these systems as yet are expensive and energy intensive.

A place where this is being tried is a pilot housing project in Lübeck-Flintenbreite in Germany where an integrated system with vacuum toilets, vacuum sewers and a biogas plant for blackwater as well as greywater treatment in reed-bed filters is under construction.

Flush facelift

Instead of focussing on the sewerage and treatment plants, flush toilets themselves can be modified to the amount of water they use. Low flush toilets that use just one litre per flush have been designed. Quite a large amount of water can be saved and recognising this, many cities, like Los Angeles, USA, are giving rebates to people willing to change their toilets to low water systems, and in some cases, provide them free.

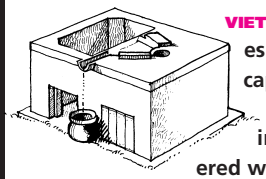
These possibilities make a large difference to the problem of water pollution. But again they presuppose sewerage lines, however small. On-plot sanitation solves this problem.

Toilets originally designed for ships and airplanes are now being adapted for houses. The vacuum toilets mentioned earlier also reduce the amount of water. Electric incinerator toilets fall into this category where the faeces and urine mixture is dried by electric fans and then burnt.

Of low-tech versions the standard on-plot solution seems to be pit latrines. These are merely holes dug into the ground and covered with superstructure that contains the toilet seat or pan. When the pit is full, it is either emptied or another pit dug and the superstructure moved to it. The old site with a topping of soil is suitable for growing trees. Instead of a straight drop, an "s" bend is attached just below the toilet pan, a water seal can be included which cuts off most of the odours. This is basically a simplified version of the septic tank. In terms of the environmental impact, both pit and septic tank toilets pose risks to groundwater. The US Environment Protection Agency has also expressed concern about the amount of groundwater contamination that is caused by septic tanks: they pose the greatest risk to groundwater in the US.

Return to nature

Traditional toilets hold ground

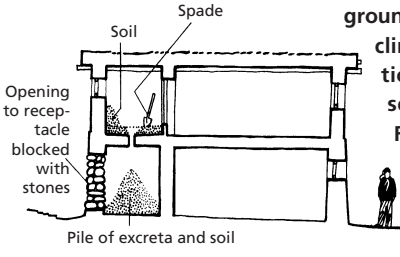


VIETNAM: The Vietnamese toilet system comprises two chambers — each with a faeces-holding capacity of 0.3 cubic metres. The chambers are built on a 10-cm thick floor to prevent flooding during torrential rainfall. They are covered with a slab that has two holes, foot rests and a groove to drain urine.

The chambers are used on a rotational basis. Five to ten persons can use each chamber for about two months. Before use, the chamber floors are covered with soil to prevent faeces from sticking to the floor. Ash is sprinkled over the faeces after every use. This absorbs moisture, neutralises bad odour and keeps the flies away. When the chamber is two-thirds full, earth is added and then it is sealed. The second chamber is then put to use. After two months, the first chamber is unsealed and the decomposed faeces are used as fertilisers. Even urine that gets drained through the groove and collected in a jar is used as fertiliser. The system, to a great extent, prevents spraying of fresh excreta in the rice fields. It also prevents contamination of soil and water resources. However, the two months retention period is too short for total pathogen destruction.

LADAKH: In most houses of Ladakh, the toilet is housed on the upper floors. It is a small room whose floor is covered with a thick layer of soil from the garden. There is a hole in the floor that allows excreta to fall into a compartment built for that purpose.

People excrete on the soil. They then shove the faeces and some of the soil into the ground floor compartment through the hole with the help of a shovel or a spade. Even the urine is drained into the ground floor room. The region's dry climate helps in the decomposition of the faeces without separating it from the urine. For better decomposition, ash together with heaps of soil is added to the pile of the ground floor room.



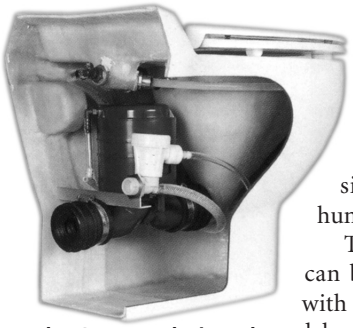
The decomposed excreta is removed during spring and at the end of summer season and then used as a soil conditioner. The advantages of this system are: no odour if the toilet is maintained well, does not lead to breeding of flies and proves to be very useful in case of short water supply. The system is working well in most rural areas of Ladakh, with the exception of Leh's central part where soil is not available in abundance.

In the desperate race for environmental sanitation, more radical designs are emerging which take ecological thinking to its logical conclusion. Why not then just get rid of the water? This is "ecological sanitation" or ecosan for short, works on the principle *Don't mix faeces, urine and water*. One need not look towards other countries for successful ecosan design. In India, people in Ladakh have been using such toilets for centuries (see box: *Return to nature*). Modern versions of ecosan have also been tried and tested in India too (see box: *Thinking clean*).

The nutrient loop

Urine is nearly sterile. Faeces, which is 10 times smaller in volume than urine, contain most of the pathogens. If the two are kept separate, urine can be directly used as fertiliser while faeces can be sanitised and used as soil conditioner. This is why ecosan is described as "closing the loop". We eat plants that get nutrients from the soil. We urinate and defecate and return the nutrients back to the soil.

Ecosan works by separating the urine and faeces at source and putting both the urine and faeces back into the local nutrient cycle. Designing a toilet pan where the urine and faeces go in different directions ensures this. The faeces drop straight down in a small storage chamber made of concrete or other impervious material. The urine goes to a tank. The faeces is stored and allowed to decompose by a process of aerobic digestion. Ash or other organic absorbing material like sawdust is used to cover the faeces to aid in the drying out process. Time allows heat, given of by decomposition, and normal soil bacteria to kill all the disease carrying organisms. Within six months, the faeces is reduced to humus.

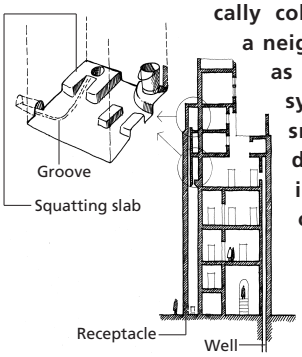


The German-designed vacuum toilet

The process used to sanitise faeces can be simply split up into two types; with urine it is a composting, without; a dehydrating process. In both, the action of time and soil microbes destroys pathogens.

YEMEN: In Yemen, most of the houses are multi-storied and each floor has a toilet situated next to a shaft. The shaft runs from the housetop to a receptacle located at ground level. The urine is drained from the toilet's squatting slab to a groove. From there it goes through an opening in the wall of the house, down a vertical drainage surface built on the outer surface of the building. Most of urine gets evaporated on its way down the drainage surface. The rest, if any, is drained into a soakpit.

The faeces get dropped through the squatting hole of the toilet, down the shaft, to the receptacle. Dried faeces are periodically collected, further dried on the roof of a neighbourhood public bath and then used as fuel for heating water. Even in this system, there is no problem of foul smell and breeding of flies. The final disposal of the excreta is also safe as burning efficiently destroys all pathogenic organisms.



However, those who empty the receptacles may at times come into contact with fresh excreta and flies may contaminate the faeces when they are being dried on the bath roof.

Thinking clean

Ecosan toilets experiments in Kerala

Paul Calvert

Paul Calvert, a Kerala-based ecological sanitation expert, has proved that ecosan approach can work in areas where water is scarce. In 1995, he built his first such ecosan toilet in a coastal village of Kerala. At that time, 80 per cent households of the village had no latrines. Moreover, at least 50 per cent of families were consuming water that was contaminated due to open-air defecation. However, the main impetus for Calvert was to provide women with some privacy.

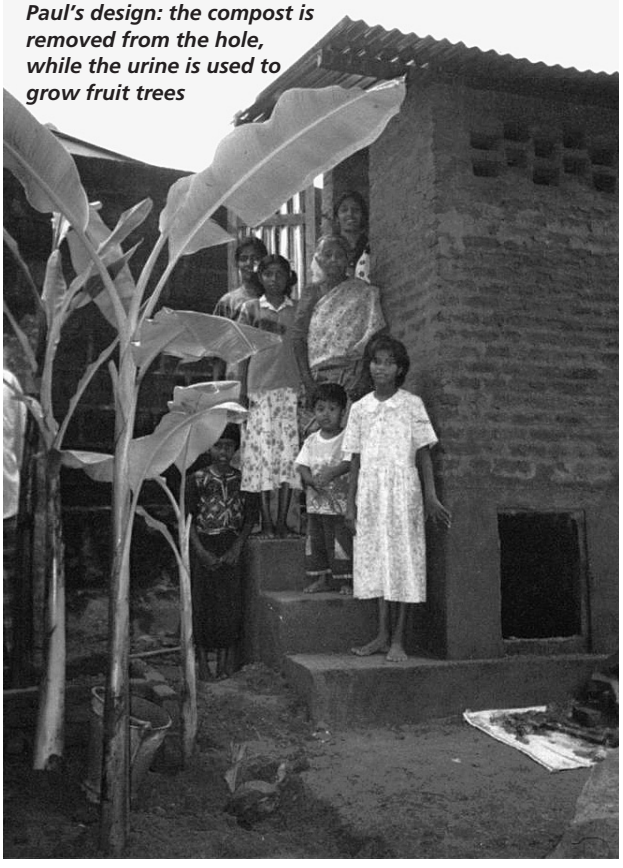
Since the water table of the area was quite high and prone to tidal flooding, building pit latrines was not considered feasible. Moreover, building a sewerage system was out of the question. Therefore, the best option was to build ecosan toilets.

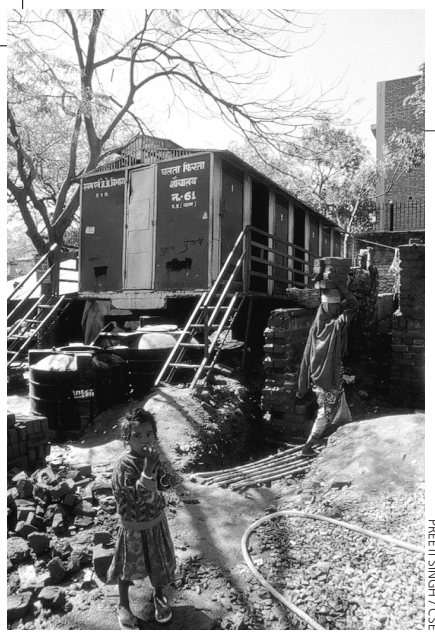
Calvert's ecosan toilet consists of a slab built over two vaults. The slab has a hole over each vault for the faeces to drop in and a funnel-like device to collect the urine. Between the two holes is a small drain over which anal cleaning takes place. The anal cleaning water and the urine is together drained into a plant bed.

After each use, a small amount of ash is sprinkled down the faeces hole to facilitate the drying process. The two holes are used on a rotational basis for six-months. Before use, each hole is covered with straw to facilitate decomposition. After six months, the decomposed faeces is used as a soil conditioner.

Though these ecosan toilets are as economical as any other sanitation system, Calvert declines to comment on the cost. "Many people judge things by the cost of the hardware. I want to promote the approach, not the hardware cost," he says. He has built ecosan toilets in other countries as well. His system can be used in high water table areas; dry, water scarce areas; rocky sites and flood plains.

Paul's design: the compost is removed from the hole, while the urine is used to grow fruit trees





PREETI SINGH / CSE

The poor cannot afford sanitation systems but pay for the cost of flush toilets

On the block

Modern ecosan toilets are already in use where laying sewage lines is a problem. In Sweden composting toilets were first introduced more than 50 years ago. Though a wide variety of models are being used, the 'Clivus' Multrum model is one of the most popular ones (See diagram: *the Clivus Multrum composting toilet*).

The Clivus Multrum is a single vault-composting toilet where urine, faeces and organic household wastes are combined and processed together. The model is available as a unit and consists of three main components: a composting vault with a slanting floor; air conduits; and a storage space at the lower end. Besides these, a tube connecting the toilet seat riser with the receptacle and a sloping channel for the kitchen waste.

Faeces, urine and toilet paper along with all kinds of kitchen and organic household wastes go into the multrum. The contents slide down slowly along the multrum sloping floor with the fresh deposits at the upper end down to the storage part of the vault. The heap decomposes, reducing to less than 10 per cent of its original volume and gradually forms humus. The humus produced has similar bacterial count as that of soil and is directly used as a fertiliser and soil conditioner. The humus produced in this process is only taken out after five years for the first time and later once a year. In Sweden, this model is used in houses, weekend houses, institutions and as public toilets. One problem is that since there is no diversion of urine the slanting floor poses a risk of liquid accumulation at the lower end of the composting vault. To stop this a container for liquid storage below the composting vault has been provided in a newer version.

Urine separating toilets can be designed for multi-dwelling environment too. Gebers Housing Project is a cooperative housing project — a two-storied building with 32 flats — located in a suburb south of Stockholm. This project involves community participation and was started in 1998 with the primary aim of recycling all nutrients of the human waste to agriculture.

The urine is flushed with a small amount of water and is carried by gravity to large tanks under the building from where it is transported to a farm and stored in large reservoirs. There is a natural rise to a high ph of urine and it is considered to be disinfected after six months of storage. Faeces on the other hand are handled dry and fall straight down into individual bins under the house. The faeces is taken out after one year and composted collectively for later use in agriculture.

There are working examples in less developed countries too. China has a large ongoing ecosan programme. In the Guangxi Zhuang Autonomous region in southeast China, Yongning county has 1440 ecosan toilets in 45 villages. In the same region, another county, Beiliu, has 3,316 dry toilets. Most of these are in houses but some are in public use like schools. The faeces are dried in the toilets themselves and are collected and used in three ways. They are put into a biogas digester and the gas made is used provide lighting and cooking facilities for the village. The leftover sludge is applied to fields as a soil conditioner along with the urine. Faecal sludge is also used for aquaculture. The circle is complete.

CHASING A DREAM

It is the poor who cannot afford sanitation systems and are paying the cost of flush toilets and sewerage. We pump our disease-laden effluents towards them. The medical interventions possible for the rich may be out of the reach of most poor people. Most deaths from waterborne diseases are not caused not by the pathogens themselves, but because of dehydration, the victims do not have enough clean water to drink. Malnutrition is also exacerbated by lack of clean drinking water. Flush toilets hijack natural resource like water that the poor depend to meet their daily needs.

Whether donor agencies or government subsidy, there is a lot of money to be made in sanitation and those in power will not easily give up that power. So governments will continue to build flush toilets and keep chasing the impossible dream of sewerage. Sanitation engineers have no interest in changing the technology paradigm. Water pollution is not their problem in any case.

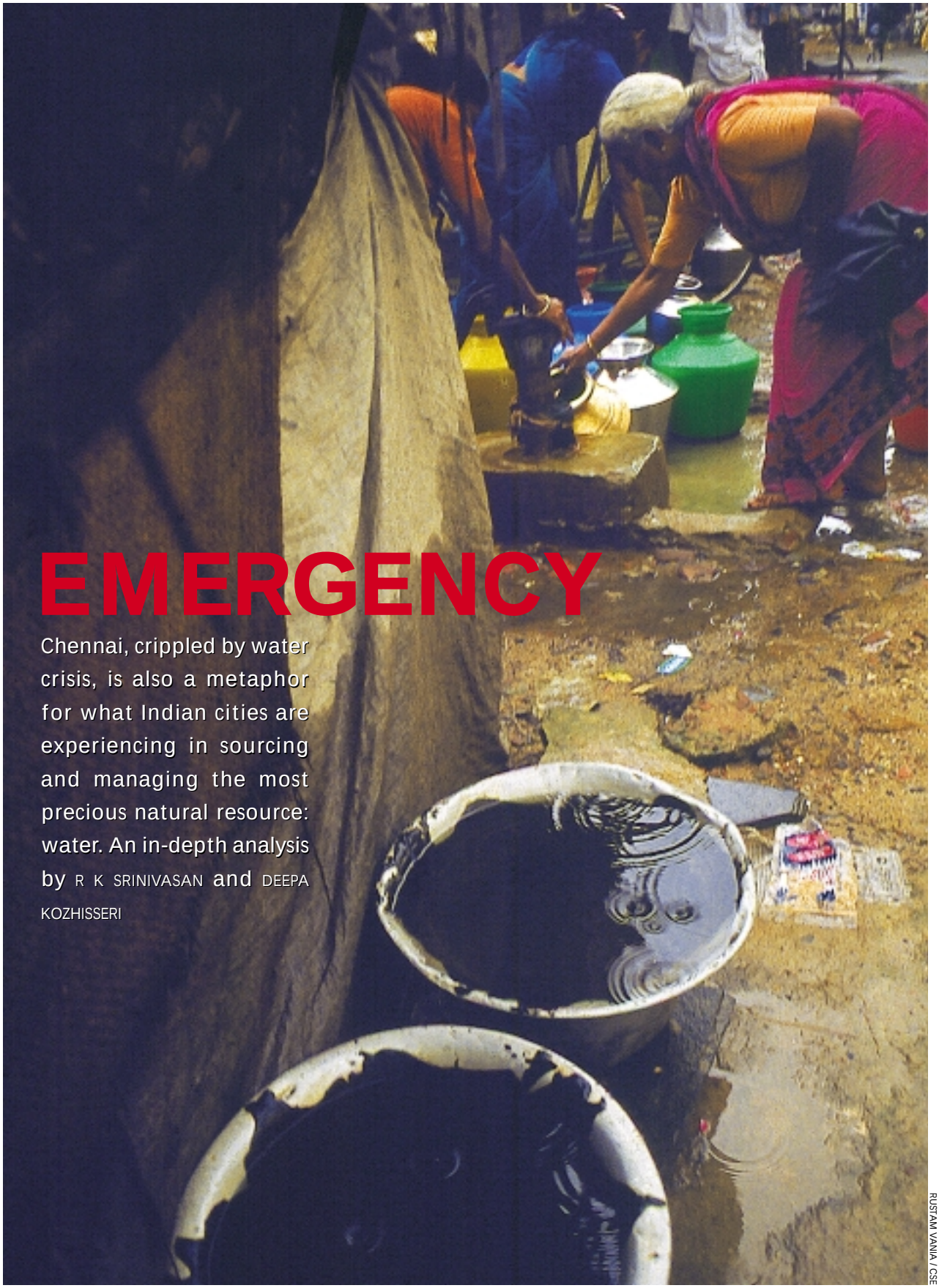
PREETI SINGH / CSE

Flush with funds: building public toilets in Delhi

There is no need to import expensive technological fixes. Ecological sanitation shows that there are new approaches, and that these are based on traditional understanding of the human-environment relationship. These are not really new technologies just a new way of looking at things. Alternatives to the flush toilets and sewerage are needed and an understanding of basic environmental cycles shows us the possibilities. Put back what you take out.

But most important need is a change in mindset. The flush and forget attitude is not working. The faster we realise this, the better. ■

With inputs from Priyanka Chandola



EMERGENCY

Chennai, crippled by water crisis, is also a metaphor for what Indian cities are experiencing in sourcing and managing the most precious natural resource: water. An in-depth analysis by R K SRINIVASAN and DEEPA KOZHISSERI

RUSTAM VANIA / CSE

A cruel summer has been left behind. Pipes are gurgling to life and the surge of water tankers on Chennai's streets is on the ebb. People and leaders are now free to discuss issues non-aqueous. There are even days when Chennai's papers skip the almost mandatory columns devoted to water. It is beguilingly close to good times.

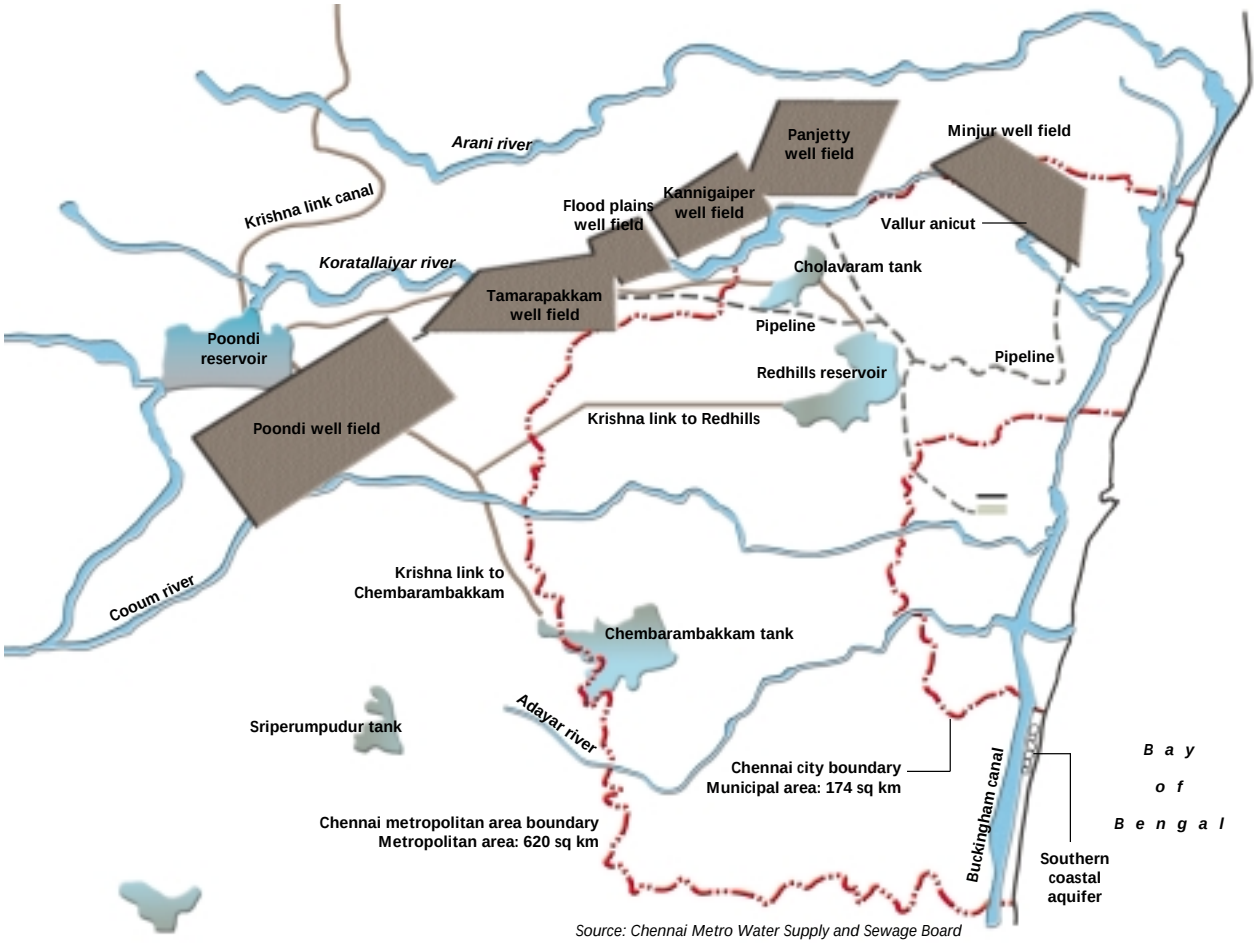
From November 15, the Chennai Metro Water Supply and Sewage Board (CMWSSB, popularly called Metro Water) resumed piped water supply for the first time since January 2004. Now, it supplies through pipes on alternate days. "This month we have purchased only three lorries of water," says S Kumuraswamy, president of the residents' association of Kadhir Kasturi Apartments, a block of flats in Adayar. Earlier, the block of flats required 11 tankers per month.

The residents' association owns a water treatment plant, with reverse osmosis technology, that converts brackish water from their borewell to drinking water. The plant now runs twice a week; till a couple of months ago, it used to run everyday. On an average, the total water bill of the apartment block is Rs 13,000 each month, which works out to an average of Rs 1,625 per household every month. And this excludes what they pay for bottled water. For comparison, consider Delhi. Even after the proposed revision in water prices, a luxury apartment will pay Rs 192 per month for water supplied at the rate of 140 litres per capita per day.

Despite resumption of piped water, several residents don't share Kumuraswamy's exuberance. "Metro Water's supply is a trickle of water laced with rust particles from the pipes," says V H Balakrishnan on Dr Radhakrishna Salai. He lives in Shanti Apartments, a block of 16 flats, which still requires six 12,000-litre tankers every month, costing Rs 700-750 each. The average cost of tankers alone to each household is about Rs 260 per month. The complex has a borewell, but its water has high iron content. So the residents had to install a filtering plant at the cost of Rs 50,000. They also pay Rs 20 per kilolitre as cost of filtering the water. In addition, the residents have to spend on bottled water. Two decades ago, the dugwell in the apartment block met the drinking water needs. Chennai relied almost exclusively on dugwells, which have now gone dry. Water from dugwells is available to all, rich and poor. As input costs of obtaining water increase, the divide becomes starker.

While the rich somehow manage, albeit at a high cost, the poor have no option but to bear with Metro Water's vagaries. In the large slum of Srinivasapuram are numerous fixed plastic tanks that Metro Water's tankers fill up daily. Each tank provides drinking water to about 100 people. In October 2004, a fire destroyed several houses in the slum. The road the tankers used was littered with debris and some belongings that could be salvaged from flames. But for a month and a half, tankers refused to serve the fire-affected part of the slum, which is right behind the Metro Water pumping station in M

Chennai basin: sources of water supply



Source: Chennai Metro Water Supply and Sewage Board

R C Nagar. The residents had to approach political leaders and threaten a strike before the water supply resumed. Now, water is available, but only to those who wake up at 3 AM to queue up. "It is only the two or three pots of drinking water that we need from them. Our remaining needs are met with the brackish water from dugwells," says M Laxmi, a resident. At the peak of the 2004 drought, the water supplied to the slum was murky. Laxmi was forced to buy bottled water — Rs 30 for a 15-litre can — she could barely afford.

The great leveller

Chennai's water crisis doesn't spare the industry either. During the summer, establishments in the Guindy industrial estate depend completely on tankers, either of Metro Water or private operators. The Small Industries Development Corporation, which set up the industrial estate, stopped providing water two years ago. That resulted in a rush to sink borewells and the water table plummeted.

R Subramanium of Aruna Rubber Industries Limited thinks he is lucky: "We have some water in our borewell because it was dug last year. Next year, it is likely to run dry." The only way now is deeper borewells, plumbing depths of 90 metres. In a coastal city, that is suicidal — it leads to seawater intruding into the groundwater. Industrial profiles of cities prepared by the Confederation of Indian Industry says water scarcity is the main hindrance to Chennai's industrial growth.

Chennai has seen better days when it could quench its thirst from its two rivers — Cooum and Adayar — and the numerous temple tanks, a distinguishing feature of the city landscape and Tamil culture. But the rivers have become sewage conduits. CMWSSB engineering director S Ranganathan acknowledges that the board partly treats the sewage before releasing it into the rivers. In addition, 50 million litres per day of untreated sewage finds its way into the rivers.

Garbage dumps and apartment blocks now stand atop the numerous surface tanks, which earlier ensured water in the dugwells. "Housing colonies have come up on the large water tanks of Spurtank Road and Kotturpuram," laments Balakrishnan. Fast running out of water sources, Chennai is running helter skelter, tapping into water sources far away from the city. Be it water of the Cauvery river, from Veeranam lake 235 km south of Chennai, or river Krishna's water from Kandaleru dam, 170 km north. Such efforts are exorbitant and result in water being snatched away from farmers. And yet they have fail to deliver what they promised.

When even distant rivers fail to suffice, Metro Water sinks new borewells in well fields north of the city. At the peak of the 2004 drought, the utility was spending Rs 1 crore *each* day on bringing tanker water to the city from these borewells. Its officials beg farmers to sell water to the city. This has drained the groundwater. In coastal areas, seawater is filling this vacuum.

All this has meant that water consumption in Chennai is perhaps the lowest among all large cities in India. During this year's drought, Metro Water supplied an average of 35 litres per capita daily (LPCD). (The National Commission on Urbanisation says the ideal supply should be 135 LPCD.) Delhi assumes a water supply of 200 LPCD. The government's helplessness in Chennai is so dramatic that there are no parallels, though most Indian cities are fast reaching a similar state.

A state in which drought is not news. Water is.

In desperation

Chennai must incessantly seek water

The reason Chennai faces chronic water scarcity: it depends on the rain it captures in its lakes, ponds and groundwater aquifers. It has no perennial rivers. So, if the city has not built reservoirs of water, one or two bad monsoons leave it crippled. If the northeast monsoon (October-December) fails, the city is in deep trouble.

And the rains have failed not for one but two consecutive years — 2002 and 2003. Last year, the city received 280 millimetres of rain, almost half the normal precipitation of 580 mm. In January 2004, the combined storage in the three major reservoirs of Poondi, Redhills and Cholavaram fell to the lowest in 54 years — 268 million cubic feet, a mere 3.6 per cent of their total capacity of 7,412 million cubic feet. Is this due to siltation and poor maintenance? A study of siltation of the Poondi reservoir from 1944 to 1983 by the public works department showed the average annual rate of siltation is a mere 0.298 per cent of the reservoir's capacity of almost 80 million cubic metres (MCM). and the annual rate of sedimentation over the drainage area is 0.031 MCM per sq km.

So is Chennai's perennial water crisis a result of nature's vagaries? Or gross mismanagement? Essentially, its politicians and scientific institutions are unwilling to accept that it doesn't have a perennial river. The fantasy that water must be accessed from a river must be realised, over and over again. So it is that over time, and conveniently increasing cost, they have reached ever farther to distant rivers. The desire to be free of monsoon dependence might be justifiable but the history of attempts to fulfil this yearning shows that the exact opposite has been achieved.

Circa 1772

Chennai's primary water source used to be a network of *eris* (tanks), ponds, temple tanks and dugwells managed by local communities. Typically, several households shared each well. In 1772, when it was under the control of the English East India Company, the 'first' public water supply works was set up. It was designed to supply 0.635 million litres per day (mld) from a cluster of 10 wells to Fort Saint George (now, the state secretariat in the city). Over the next 100 years, a larger scheme was completed. This brought water from two *eris* — Cholavaram and Redhills — to municipal waterworks, distributing it across the city.

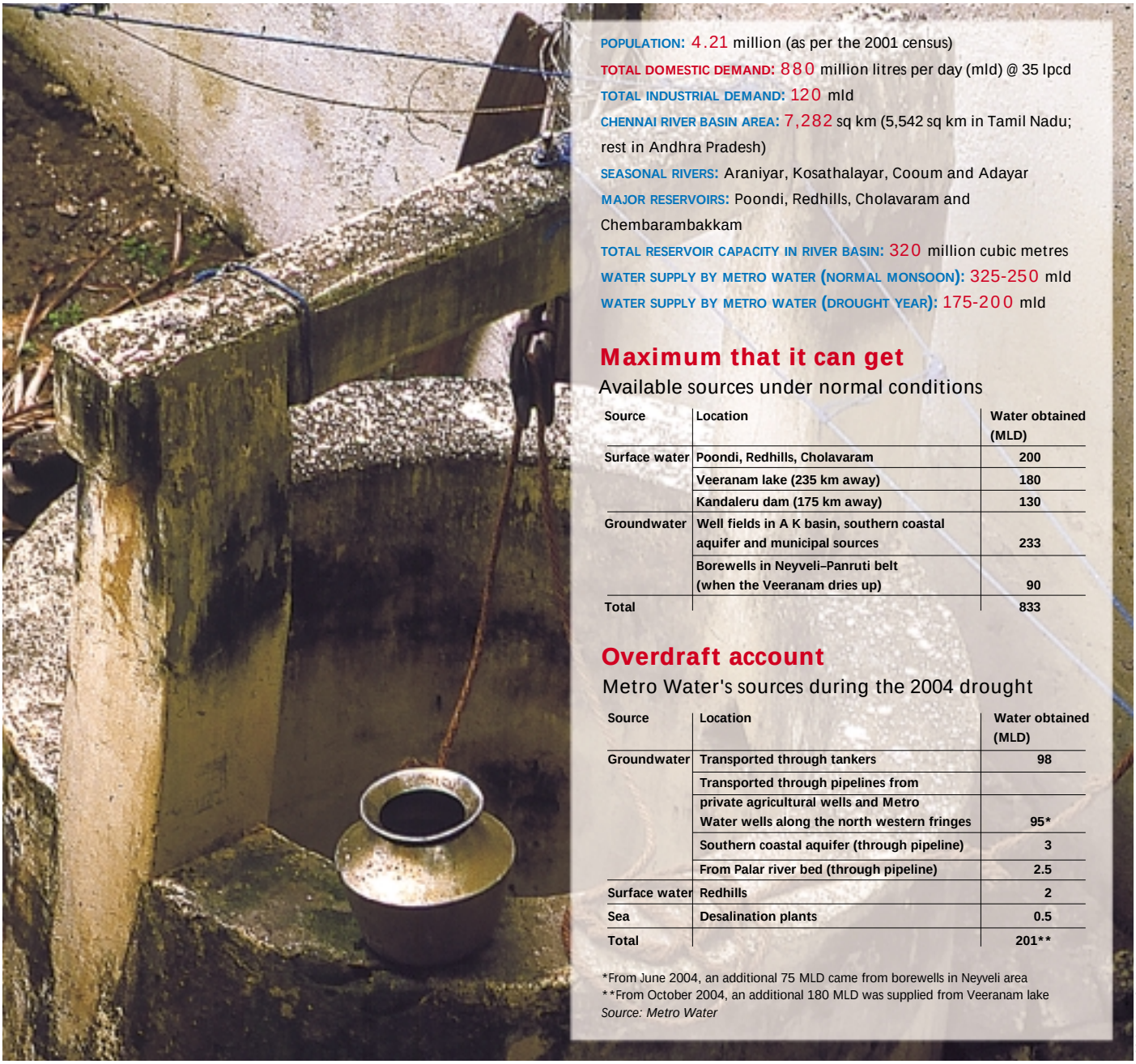
These two tanks met the growing city's demand till the early 1900s. Between then and the 1940s, the city's population doubled to almost one million. To meet the growing demand, a reservoir was constructed at Poondi across the Koratallaiyar river. This raised the total surface storage capacity from 100 MCM to 180 MCM. Till the 1970s, the city's public water supply system depended exclusively on these three reservoirs, located 20-50 km to its northwest.

Chennai's water worries had already begun in the 1950s. R Muthuswamy Pillai was the mayor in 1954. He contacted an American firm to explore the possibility of arranging artifi-

cial rain to combat drought. In 1957-58, the then chief minister C N Annadurai invited the United Nations Development Programme (UNDP) to find out the feasibility of setting up a desalination plant. "But the (UNDP) team recommended that instead of seawater, the groundwater in the Araniyar-Koratallaiyar basin (northwest of the city) be utilised to fulfil the drinking water requirements... when UNDP started drilling borewells in the area, the farmers realised the groundwater potential and started doing the same," says R Sakthivadivel, Patancheru-based senior fellow of the International Water Management Institute, a think tank in Colombo, Sri Lanka.

As the city continued to grow, water availability fell from a comfortable 140 litres per capita per day (LPCD) to a low 80 LPCD in 1971. The public system was under additional pressure to extend its distribution network to new areas being developed. This led to installation of public taps, borewells fitted with hand pumps and large tanks to store municipal water. In 1976, the politicians became fixated with the idea of the river as the source of water. The closest was Krishna, 170 km north of the city, and the Telugu Ganga Project was drawn up. But work proceeded at a snail's pace: the first phase of the project was commissioned in 1996. However, the scheme has failed to live up to its promise (see box: *The flow and the ebb*).

Chennai's water search also took it to the well fields of the Araniyar-Koratallaiyar basins 40 km northwest. More sources were brought under the control of Metro Water when it was formed in 1978. The wells in Tamaraipakkam, Panjatty and



ANIL AGARWAL / CSE

POPULATION: 4.21 million (as per the 2001 census)
TOTAL DOMESTIC DEMAND: 880 million litres per day (mld) @ 35 lpcd
TOTAL INDUSTRIAL DEMAND: 120 mld
CHENNAI RIVER BASIN AREA: 7,282 sq km (5,542 sq km in Tamil Nadu; rest in Andhra Pradesh)
SEASONAL RIVERS: Araniyar, Kosathalayar, Coum and Adayar
MAJOR RESERVOIRS: Poondi, Redhills, Cholavaram and Chembarambakkam
TOTAL RESERVOIR CAPACITY IN RIVER BASIN: 320 million cubic metres
WATER SUPPLY BY METRO WATER (NORMAL MONSOON): 325-250 mld
WATER SUPPLY BY METRO WATER (DROUGHT YEAR): 175-200 mld

Maximum that it can get

Available sources under normal conditions

Source	Location	Water obtained (MLD)
Surface water	Poondi, Redhills, Cholavaram	200
	Veeranam lake (235 km away)	180
	Kandaleru dam (175 km away)	130
Groundwater	Well fields in A K basin, southern coastal aquifer and municipal sources	233
	Borewells in Neyveli–Panruti belt (when the Veeranam dries up)	90
Total		833

Overdraft account

Metro Water's sources during the 2004 drought

Source	Location	Water obtained (MLD)
Groundwater	Transported through tankers	98
	Transported through pipelines from private agricultural wells and Metro Water wells along the north western fringes	95*
	Southern coastal aquifer (through pipeline)	3
	From Palar river bed (through pipeline)	2.5
Surface water	Redhills	2
Sea	Desalination plants	0.5
Total		201**

*From June 2004, an additional 75 MLD came from borewells in Neyveli area
**From October 2004, an additional 180 MLD was supplied from Veeranam lake
Source: Metro Water

Minjur fields were reserved for industry in north Chennai. Over the years, these wells were diverted for domestic use, forcing several industrial units to sink private borewells. As the shortfall in water supply continued to rise, Metro Water later insisted that industries use treated sewage for part of their needs.

As surface water projects couldn't meet the increasing demand of Chennai, more borewells were sunk in newer well fields. By 1987, there were five well fields supplying water to the city. To cope with the worsening situation from the early 1980s, aquifers in Poondi, the floodplains of the Koratallaiyar and Araniyar rivers and the south coastal aquifer began to be exploited (see table: *Withdrawal symptoms*). In 1993 and 1999, water from Chembarambakkam lake, 26 km southwest of the city, was diverted for the city.

In the 1970s, Chennai's water search turned southwards, beyond Pondicherry, to the Veeranam lake 235 km away. Work began on the Veeranam project, which envisaged a pipeline from the lake. But the project had to be shelved in 1975 amid allegations of corruption that brought a lot of bad press to chief minister K Karunanidhi of the Dravida Munnetra Kazhagam (DMK) party. In 1995, his political opponent and the then chief minister Jayalalithaa took up the project at a budgeted cost of Rs 464 crore.

In 1996, the DMK was back in power and it dropped the project after the World Bank raised objections and refused to fund it. In 2001, Jayalalithaa returned to power. She relaunched it in February 2003 as the New Veeranam Project. It was completed in June 2004, when the lake was dry (it remains dry from February to July every year). The lake is supposed to get water from the Cauvery river, but the long standing dispute with Karnataka has ensured this doesn't happen. To feed the pipeline, borewells were sunk in a 25 km stretch, causing the water table to plummet and the farmers to agitate (see box: *Water doesn't flow*).

Over the years, groundwater has become *the* major source of water (see table: *Overdraft account*). But the city's falling water table impelled exploitation of distant aquifers, adding to the costs (see table: *Distance yearning*). In 2004, Metro Water supplied water to the city through tankers for about six months at a cost of Rs 1 crore per day.

On an average, Metro Water gets 70 MLD of water through 1,700 tankers from neighbouring villages. The board buys this water from farmers after obtaining an acceptance letter from them. The state government also drew up a Rs 145 crore relief plan for additional borewells near the existing well fields to the north of the three major storage reservoirs. But this level of groundwater mining will last, at best, a few years.

PHOTOGRAPHS: DEEPA KOZHISSERI / CSE

Flow and ebb

Krishna waters don't reach Chennai

The Telugu Ganga Project was conceived in the 1970s by the then prime minister Indira Gandhi, Telugu leader N T Rama Rao and Tamil leader M G Ramachandran. All the three are now dead, leaving the fate of the project to the ever fluctuating equations between the chief ministers of Tamil Nadu and Andhra Pradesh (AP). Water supply from the project to Chennai has been severely reduced by seepage as well as pilfering farmers.

As far back as 1976, AP, Maharashtra and Karnataka agreed to divert 12 thousand million cubic feet (TMC ft) to Chennai every year. But the project's first phase was commissioned only in 1996. It was expected to bring 5 TMC ft — 380 million litres per day (MLD) — from the Srisailam reservoir across the Krishna, through the Somaseelam reservoir on the Pennar river, and subsequently, through an open channel, to Poondi. The capacity of the city waterworks was increased to 300 MLD in anticipation of 8 TMC ft during July-October and 4 TMC ft during January–April .

But this amount hasn't reached Chennai since 1996. In seven years (1996-2003), the project delivered a total of 15 TMC ft to Chennai, instead of the projected 84 TMC ft. However, the water reaching the city has been considerably less than receipts at the state border show because of seepage in channels and other losses en route. It is estimated that 5 TMC ft at the state border adds a mere 1.5 TMC ft — less than one third of the original — in the reservoirs.

On February 16, 2004, the Krishna river water released from the Kandaleru reservoir in Andhra Pradesh reached the state border near Uthukottai in Tamil Nadu after travelling 152 km. It was to reach Poondi, and then course 35 km down the Baby canal to the Redhills reservoir for being treated and ferried in tankers. But such hopes evaporated on February 18 with the Poondi canal remaining dry. This was attributed to illegal tapping of water by farmers and the withdrawal of water to meet the demands of Tirupati town in AP. "The increasing height of the Almatti dam in Karnataka is also one of the reasons, as the water gets stored in Srisailam dam which then flows to Kandaleru dam," argues S Ranganathan of Metro Water.

As per a 1997 estimate, the total cost of the project is Rs 2,400 crore, of which Tamil Nadu's share is Rs 640 crore. The second phase of the project is expected to provide an additional 7 TMC ft per year at the Tamil Nadu border by 2011. But even if the water is released as scheduled, how much will reach the city? While the viability of the project is in question, there is no discussion in Tamil Nadu of its failures and potential. All politicians maintain a studied silence on the matter as the project is perceived as a legacy of former chief minister M G Ramachandran, in whose name both the main political parties slug it out at the polls.

Farm water for the city

During the 2003 drought, Metro Water bought from farmers the rights to pump water from nearly 164 borewells. In 2004, it bought rights to another 44 borewells from farmers. Under the agreement, farmers are paid Rs 40 per a 10,000-litre tanker. A majority of the farmers have small landholdings that don't earn them much. They prefer to sell water from their borewells as that earns them more money.

Withdrawal symptoms

Groundwater extraction from well fields

Well fields	Year of commission	Number of wells	Safe yield (in MLD)
Minjur	1965	12	25
Tamaraipakkam	1979	22	32
Panjetty	1969	12	36
Flood Plains of Koratallaiyar	1987	5	13
Kannigaiper	1987	9	15
Poondi	1987	15	27
Total		75	148

Rs 1 crore every day

Metro Water's daily water sheet

	November 2003	January 2004	March 2004	May 2004
Amount of water ferried over long distances by tankers (MLD)	38	74	140	203
Number of tankers hired	595	726	1,100	1,300
Number of daily trips	6,733	7,555	9,500	12,000
Number of fixed plastic tanks installed	10,030	10,430	11,315	13,500
Number of new borewells sunk	5,500	6,500	7,000	7,500
Daily expenditure (in Rs lakh)	55	70	85	100

Source: Metro Water

And Metro Water isn't just drawing from well fields but also from irrigation tanks. In January 2004, thousands of farmers, residents and members of political parties from Maduranthakam and neighbouring villages formed a human chain on either side of the Grand Southern Trunk Road. They were protesting the government move to pump water from their 810-hectare irrigation tank to give Chennai some drinking water — the tank hasn't filled up for several years. It irrigates more than 10,100 hectares in Maduranthakam and 20 neighbouring villages. It also provides drinking water. The pressure mounted by farmers compelled Metro Water to drop its plan to tap 2 MLD of water from the Maduranthakam tank.

This raises a great fear: irrigation enables almost 40 per cent of the water to seep back in to the aquifer. Now, the water is being drawn up and out without that level of recharge, shows a micro-level status report of the Chennai basin, commissioned by the Centre for Science and Environment (CSE), New Delhi. The study, conducted by hydro-geologists K R Sivaramanan and S Thillaigovindarajan, who formerly worked in the state government's groundwater unit, sounds another alarm.

Hydrogeology says once the dynamic groundwater reserves are exhausted and the deeper, static reserves are exploited, replenishment of groundwater levels can't happen to the previous levels. Doesn't matter if irrigation is resumed, rainfall is good, or even a flood occurs. The farmers' borewells have been drawing water continuously. The aquifers are so exhausted that these bores now yield less than half of what they used to in 2003, while some have dried up completely. This is

Water doesn't flow

Out of the barrel of a pipeline

Touted as the solution to all the water problems of Chennai, the New Veeranam Project is Tamil Nadu chief minister J Jayalalithaa's hobbyhorse. Under the project, a pipeline has been built to bring 180 million litres of water per day to Chennai from the Veeranam lake in Sathiathopu, Cuddalore district, 235 km away. The project was launched in February 2003 and completed in June 2004. But the World Bank-funded, Rs 720 crore-project was unable to provide the lake's water to Chennai when it needed it the most. This is because every year, from February to July, the lake stays dry.

The Veeranam lake gets 75 per cent of its water from the Cauvery river, according to a study conducted by Annamalai University in 2002 (the remaining coming from the 427.5 sq km catchment during the northeast monsoon). Tamil Nadu and Karnataka have been locked in a 30-year-old bitter dispute over the river's water. As the lake was dry when the project was completed, Jayalalithaa had 45 borewells sunk along the length of the pipeline and connected to it. But villages located along the pipeline feel cheated — the water going into the pipeline is the irrigation they are denied.

On November 5, 2004, villagers of Kannakudi in Cuddalore district held a protest, demanding water for their fields. The demand was ignored; Chennai's thirst was more important than irrigation. "Then came the rains. The lake got filled up. They released the floodwaters on to our fields, inundating about 5261 hectares (ha)," says V Vijayaragavan, a farmer from Kannakudi. On November 11, the villagers held a protest, this time demanding flood relief. Due to repeated droughts, several farmers in the region are in heavy debt.

Says K Venkataraman, who represents a farmers' collective in Chidambaram district and is organising a farmers' movement to demand their riparian rights: "The government says it is supplying only the excess water from Veeranam to Chennai. The reality is that farmers here don't have enough water for a single crop." Most farmers have stopped growing their first crop (July-September) over the past 30 years because the dam gets very little

water from the Cauvery. They started relying solely on the second crop (September-January) irrigated by the lake's waters during the northeast monsoon. Now, the northeast monsoon water is being taken away from them to quench Chennai's thirst. Farmers with large landholdings dug borewells. And then saw them go dry. In May-June several farmers migrated to towns in search of casual employment. "People here are willing to sell their land. But who will buy it?" wonders M S Rajendran of Mailimulanggadi.

The Veeranam lake, constructed more than a millennium ago by the Chola dynasty, irrigates 7,200 ha through 24 canals and is the only source of irrigation in the area. S Ranganathan, engineering director of Chennai Metro Water, maintains the Veeranam project takes the farmers' rights into consideration. How? By raising the lake's bund by 0.6 metre, thereby increasing the lake's capacity. One visit to the lake nails the lie — several gaps have been left in the overlying bund to allow villagers access to temples and the lake for their day-to-day activities. The money spent on the overlying bund under the New Veeranam Project is a complete waste.

Kodumpully village doesn't mind Chennai getting Veeranam waters. But the borewells dug to compensate for the absent lake water hurts them. These bores have been sunk in close proximity. As a result, farmers' borewells and dugwells within a 3 km radius are showing alarming groundwater depletion. E Velmurugan of Marua village can irrigate only one-third of the land he irrigated last year. "If they run their borewells through the year, we will be wiped out," he fears. Between the villages of Marua and Vadalur are 15 Metro Water borewells. "We sunk a borewell to 27 metres 30 years ago, then another at 60 metres 15 years ago, and now we are plumbing depths of 76 metres, at a cost of Rs 1.5 lakh each. There is no recharge of groundwater," says A M Das of Vadalur.

"If their bores operate for two hours, we lose water for irrigating 45 cents (0.18 ha)," calculates A Raja of Vadalur. Villagers of Marua and Oonamkupam submitted a petition to the district collector against the Metro Water borewells, but there was no response. The villagers' main complaint: the government bought land from them to lay a pipeline, not to sink borewells. Now, the government plans to sink borewells upstream of Veeranam lake, in the basin of the Kollidam river, which is supposed to bring water from the Cauvery to the lake.

Pattali Makkal Katchi (PMK), a political party that is part of the United Progressive Alliance government at the Centre, has filed a petition in the Madras High Court against this groundwater exploitation. "The borewells will lead to a water crisis in Neyveli area —being close to the sea, it will witness greater sea water intrusion into the ground," says K Balu, the party's advocate. PMK's petition warns that the entire Cuddalore district would turn into a desert, causing irreparable damage to the farmers. The court has asked the state government to respond.

Dry run: 235 km

Borewells substitute for the dry Veeranam lake

The final option

Desalination

With the surface and groundwater options either running dry or proving highly undependable, Chennai is now looking at the sea. In several parts of the world, desalination projects have reliably met the water needs of large urban populations and in a cost-effective manner. Chennai's experience with treating brackish groundwater has been positive (see table: *Saline features*). Metro Water has established five such units. Using the technology of reverse osmosis, the plants provide potable water to about 40,000 people at the rate of Rs 36 per kilolitre.

Exactly what will be the cost of a working desalination plant (treating seawater) in Chennai is not known as yet. A Rs 1,000 crore seawater desalination plant for Chennai is on the anvil. Union finance minister P Chidambaram, who is from Tamil Nadu, said the plant will be executed and operated by the state government. The Chennai Desal Company Limited was formed in June this year to take up desalination projects. The company's directors would include the managing director of Chennai Metro Water and the commissioner of the Chennai Corporation.

Varying estimates have been given for various technologies based on model desalination plants, with the minimum treatment cost of Rs 50 per kilolitre. The cost of desalinated water will far exceed the cost of water from other sources.

Saline features

Treating brackish water

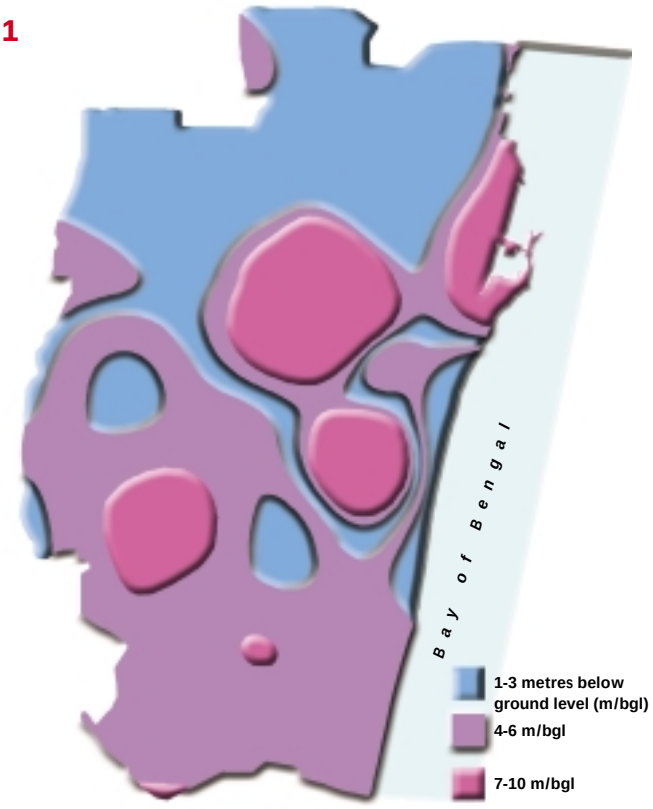
No of desalination plants	5
Plants in operation	4*
Aggregate capital cost	Rs 1.73 crore
Quantum of water produced	500,000 litres per day
Cost of water	Rs 36 per 1,000 litres

*The fifth plant is closed for maintenance
Source: Chennai Metro Water

drawing in seawater into the aquifers, taking the problem to another level (see map: *Salt attack*). The groundwater of agricultural areas will suffer the same fate as the groundwater of Chennai city. What is this fate?

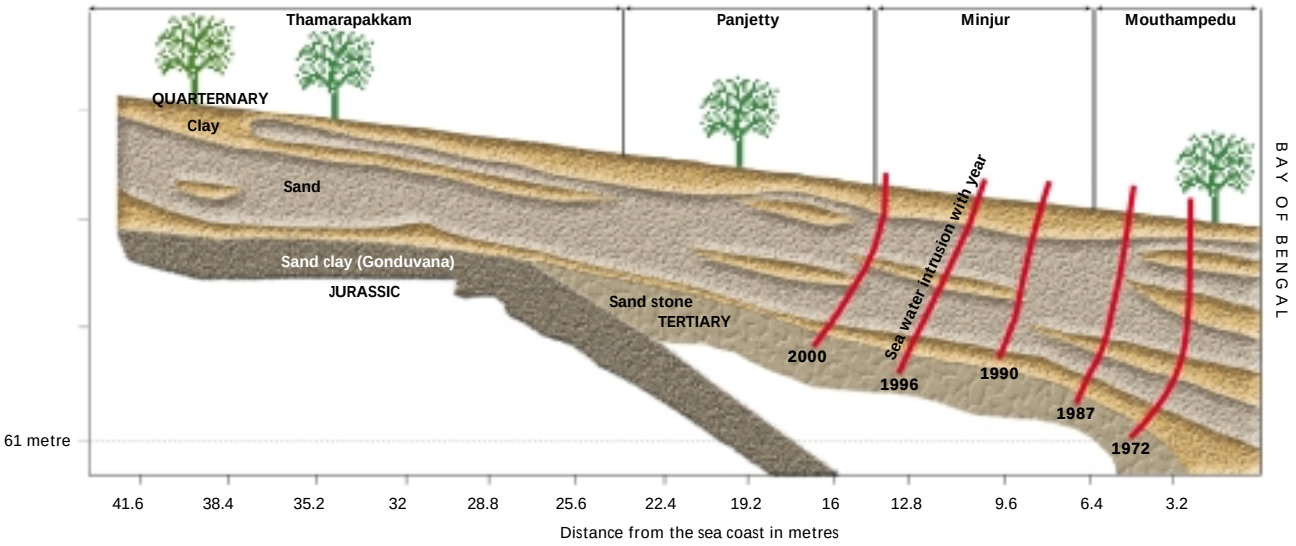
In the red

Overextraction + no recharge = falling groundwater



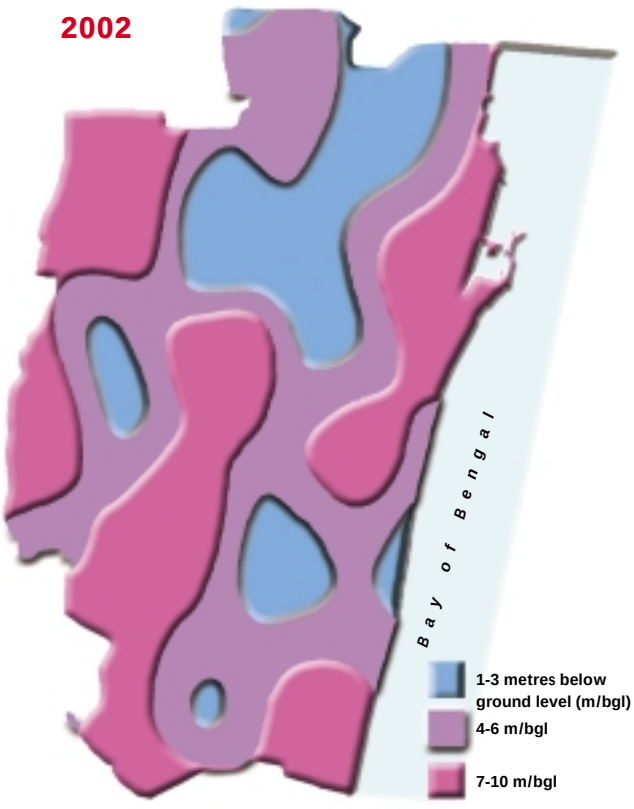
Salt attack

Seawater is increasingly infiltrating the drained well fields north of Chennai



Groundwater decline

Overexploitation and limited recharge have severely depleted groundwater in Chennai. Open dugwells, the most important source of groundwater, have had to be replaced with the deeper borewells. In the coastal areas, this has led to seawater ingress, irreparably damaging the coastal aquifers. Borewells drilled in Triplicane, Royapettah, Besant nagar areas now yield brackish water with high salt content.



To estimate the change in Chennai's water table, the CSE study prepared maps using data from observation wells, which are borewells used solely to monitor the groundwater, for 1991 and 2002 (see map: *In the red*). In 2002, the water table had fallen throughout Chennai by 7-10 metres as compared to the 1991 level. Northern Chennai and the coastal areas showed the greatest decline. Metro Water's data also shows similar level of decline. According to Ranganathan, the water level fell by 10 metres between 1999 to 2004.

The borewells are plumbing deeper every year. For instance in North Chennai, particularly in Thiru-vi-ka Nagar, bores go deeper than 100 metres. Even at this depth, some of them are going dry. In central Chennai, water was previously tapped from the alluvium formation at a depth of 25 metres, followed by hard rock. Now, this resource is exhausted and borewells are tapping the underlying rock formation. In southern Chennai, which has hard rock formation, borewells are drilled to a depth of 50-60 metres through minor fractures. This desperation to tap into any groundwater anywhere obviously overlooks quality issues.

Taking note of declining water table in the city and its surroundings, the state government passed the Madras Metropolitan Area Groundwater (Regulation) Act in 1987. It applied to 285 notified villages where free extraction of groundwater is permitted only for domestic use, and extraction for commercial activities requires a permit. But the act has failed because private tanker operators were allowed to draw water without permits in 2004 in the face of the water crisis.

One-fifth of Chennai's water supply comes from private operators who form a powerful lobby. In 2002, the government amended the act, making it applicable to 305 villages. But even the amendment has failed to check the private tankers, who have become quite influential.

All bottled up

An exclusive survey shows Chennai's reliance on private tankers and bottled water is increasing

The perpetual water shortage in Chennai prompted the Centre for Science and Environment (CSE) to study the different facets of the problem. A Vaidyanathan, eminent irrigation economist, and water researcher J Saravanan conceptualised and supervised the survey, which was carried out by students of the Madras Christian College. The survey covered over 1,510 households throughout the metropolis and collected data on water use. The 155 wards of the city were divided into three broad categories according to the water availability based on the assessment by Metro Water officials. Each of the three categories were sub-divided into upper, middle and low income groups; nine in all. A random sampling procedure was used to identify the households to be included in the survey, conducted from December 2003 to January 2004.

The number of sample households selected in each of the nine groups was in proportion to the total number of households in the respective groups (obtained from the census). Households for the survey were selected from randomly identified streets within each sample ward. Ten households from each selected street should be surveyed. Thus, 1,510 sample households were identified from 151 streets in 31 wards spread over the city. The survey was designed to elicit details of sources of water, water use pattern, storage tanks and sumps, the characteristics of dugwells/borewells, and implementation of rainwater harvesting.

Some years earlier, a large scale survey of water use in the city had been conducted by A M Murugappa Chettiar Research Centre. It showed the per capita water consumption (measured as litres per capita daily or LPCD) was considerably lower than the 135 LPCD taken as the norm for a metropolis and that public sources accounted for less than half of the total consumption. Though it was known that use of groundwater from private wells (including borewells) was rampant and the water table was plummeting, hard data was not available. The CSE survey not only filled this gap, but found some striking facts:

- Contribution by Metro Water to the city's water requirement is dismal

Metro Water provides 79.8 million litres per day (MLD), which is barely 34 per cent of the water requirement of 235.3 MLD. The people have to make up for the deficit on their own: from dugwells/borewells; private tankers and bottled water.

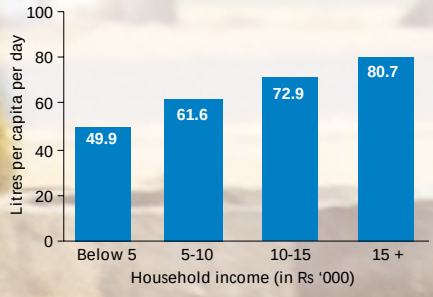
To find out the total water consumption, the mean per capita consumption found through the survey was multiplied by the population for each of the nine groups and then their sum was calculated.

- The rich consume more water

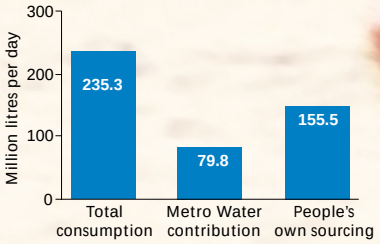
About 42 per cent of the households surveyed had a monthly income of Rs 5,000 or less, 28 per cent were in the Rs 5,000 to Rs 10,000 range, 23 per cent in the Rs 10,000 to Rs 15,000 range and the remaining 7 per cent were in the income bracket above Rs 15,000.

The per capita consumption varies from about 50 LPCD to 80 LPCD depending upon the monthly income. The low income groups consume 50 LPCD, with an increase of almost 10 LPCD for each higher income slab. The volume of water consumed for drinking and cooking is almost the same for all households, but varies drastically for uses such as cooking, washing, bathing and toilet purposes.

Per capita consumption income-wise



Who contributes how much



- Dependence on groundwater increasing

Whereas earlier, individual houses had dugwells of 10 metre to 15 metre depth, the survey shows people are now opting for the deeper borewells (more than 30 metres).

This is an indication of falling water tables because of over-exploitation of groundwater.

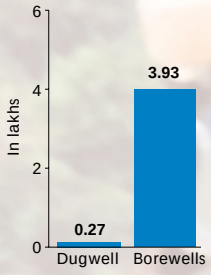
Based on the number of wells reported from the households surveyed, the average number of wells per household for each ward, and in turn for all the nine groups, was worked out.

CSE survey estimates that there are 420,000 wells with a density of 2,400 wells per sq km in Chennai is spread. Of these, 393,000 are borewells while 27,000 are dugwells.

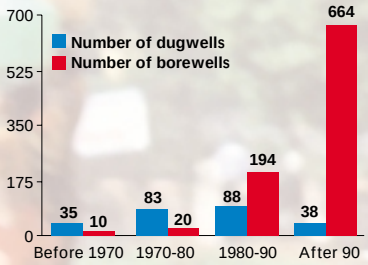
During the survey period, the water crisis was so severe that even the public system was totally dependent on groundwater extraction — from borewells in the A K basin, southern coastal aquifer and from hand pumps within the city limits.

There has been a spurt in the number of borewells after 1980 and their depth is increasing.

Total wells in city



Wells in surveyed households



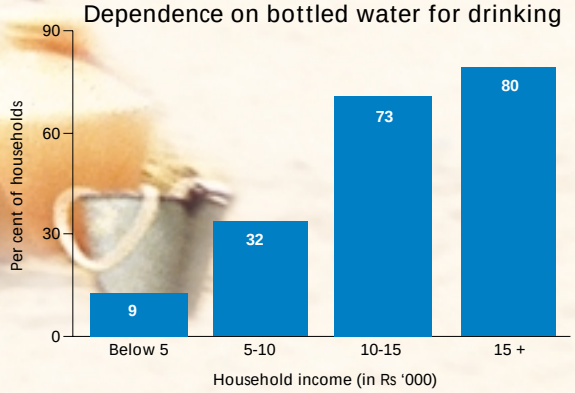
- Poor depend more on Metro Water

The dependence on the municipal water supply is more in poor households. More than half of their water requirement is met through Metro Water. In the highest slab studied, less than 10 per cent of the requirement was met through Metro Water and most of the demand was met through well water.

- The dependence on bottled water is significantly higher in rich households.

The survey shows 28.3 per cent of households are dependent on bottled water for drinking purpose and 7.6 per cent of households are dependent on bottled water for cooking.

Dependence on bottled water for drinking

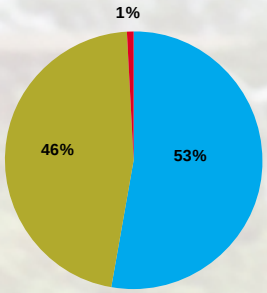


Source: CSE household survey

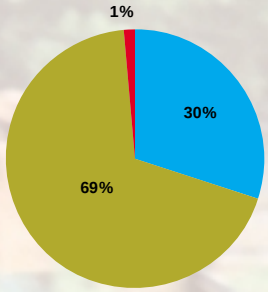
- How income levels affect water use patterns

The higher income households depend less on the public water supply system and more on the private water suppliers (through tankers) and bottled water as compared to low income households.

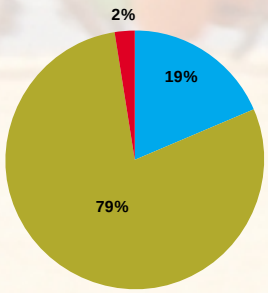
Below Rs 5,000



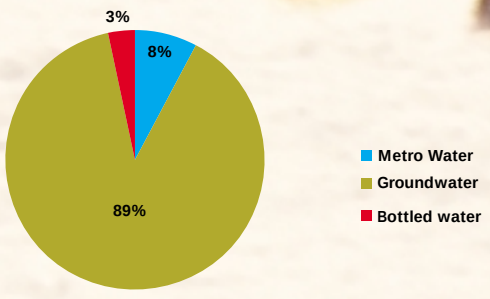
Rs 5,000-10,000



Rs 10,000-15,000



Rs 15,000 and above



RUSTAM VANIA / CSE

Tanker economics

Sign of things gone horribly wrong

The water tanker has come to symbolise Chennai's water crisis. From January to October this year, Chennai Metro Water hired private agricultural wells and engaged lorries to supply water as its sources ran dry. "We were supplying water only through lorries (not pipes)," says S Ranganathan, engineering director of Metro Water. The lorries were discontinued only after water arrived through the New Veeranam project in November.

Metro Water paid the farmers Rs 40 for every 10,000 litres and transport and delivery costs came to Rs 80 per kilolitre. The farmers are not amused. V Samantham, a farmer in Kannigaiperu village in the well field area, calculates his costs: "Selling water to Chennai doesn't earn me as much as cultivation. If I sell 15 tankers of water per day for three months, I get Rs 72,000. If I grow paddy on my 2.6 hectares, I earn Rs 1,30,000." So why does he sell the water? Because Metro Water officials came to him and begged to quench Chennai's thirst — the utility's borewells had gone dry. But a majority of farmers have smaller landholdings with lower incomes, and it actually makes better sense for them to sell the water.

In turn, Metro Water charged Rs 650 for a 9,000 litre tanker. Payments had to made only through demand drafts, which most customers found bothersome. For piped water supply, Metro Water charges a flat rate of Rs 50 per month — meters don't work given the lack of pressure in the pipelines. This is regardless of availability.

Metro Water used around 1,200 lorries of 9,000 litres and 6,000 litres. Each made 10-13 trips daily. In addition, about 2,000 lorries with a 10,000 litre or 20,000 litre capacity ferried water from distant sources. "We incurred an additional cost every day of Rs 1 crore during the peak of the drought this year," Ranganathan informed.

With absolutely no water being supplied by Metro Water through the pipeline for nine months, private tanker operators became big players. At the peak of the crisis, about one-fifth of Chennai's demands were met by private operators, who have become an influential lot. Even the Chennai Metropolitan Area Groundwater (Regulation) Act was relaxed for them this year. "We approached the revenue minister in July 2004. The matter went up to the chief minister. We pointed out that as there's a demand, we have to provide water," says G Raja, secretary of the Tamil

The long haul

Production cost of water from various sources as compared to the selling price

Source	Cost (Rs Per kilolitre)
Red hills	4
Telugu Ganga (Krishna water project)	6
Veeranam	22
Reverse Osmosis	45
Domestic Borewell	3
Private tanker	70
Metro Water's selling price	2.5

Source: Chennai Metro Water

Nadu Drinking Water Lorry Owners' Association, which owns 600 lorries.

One of the worst affected areas was the Anna University, whose Centre for Water Resources (CWR) is in the forefront of research on water related issues. CWR director K Karunakaran says, "This summer most of the borewells on the campus dried up. For a period of six months, the university was completely dependent on water tankers — the university purchased 22 tankers per day." This worked out to an astronomical monthly cost of Rs 4,95,000. Residents realised that a quick payment to the driver was essential to get a tanker in time. Says Rekkha S of Radhakrishna Salai: "I live in an independent house a little away from the main road. I had to pay Rs 200 extra for each tanker." Being a tanker driver is an enviable job. Ashirvatham B hails from Poondamalee. Eight months ago, he quit being a taxi driver and jumped on to the tanker bandwagon: "It is a seasonal job. But we make good money during the season. This summer, a lot of us have switched to tankers. At least 50 of us are from my area." He ferried as many as 10 loads a day from Poondamalee when the water shortage was at its worst.

Tanker operators built contacts in areas such as Poonnamallee, Kundrathur, Medavakam and paid the farmers Rs 100 for every 12,000 litres (Metro Water paid Rs 60 for the same). "There were nearly 1,000 private lorry operators on Chennai's roads during the peak of the crisis. Now there are around 200. Many had come from outside Chennai and were outside our control," informs Raja. The average number of daily trips of tankers have come down from five to three.

Bottled water

Besides water tankers, another common sight in the city is tempos carrying cans of drinking water. Wayside stores stock small pouches of water that people sip while on the move. The 200 millilitre pouches cost Re 1 each.

Saravana and Selvarathinam Stores in T Nagar is the neighbourhood store for milk and packaged water. A litre of milk sells for Rs 12.50, a 12-litre can of water costs Rs 50. Water sales are higher. The can is also delivered to the doorstep. "It is a growing market and only 10 per cent of it has been captured so far," says M Suresh Kumar of Sabols, a packaged drinking water chain. What needs to be built up, he insists, "is the awareness of water quality." He claims his manufacturing units in Sriperumbadur and Coimbatore — their raw material is groundwater — are the first in the country to be accredited by the South Asian Drinking Water Association. He sells 3,000 bottles of 20 litres every day. "During the peak of summer, it crossed 5,000. Groundwater is treated through reverse osmosis."

Waterman Water Products has found a good location. The small factory is on the Koratallaiyar riverbed. It claims to sell ozonised water. During high season, it was selling 1,000 cans of 25 litres each. Bottled water units are sprinkled across the neighbourhood promising purified, treated water. But almost all draw groundwater and package it without treatment. Vinayak Murthy, general secretary of the Tamil Nadu Packaged Drinking Water Association, says there are 340 packaged water operators in Tamil Nadu, 270 of them in Chennai. Production average in these plants is said to be 34,000 litres per hour.

Raintapping

A government diktat doesn't harvest

The reality of Chennai's dependence on rain is not fully appreciated. If it were, then rainwater harvesting (RWH) would have been looked upon as a social obligation. Considering the annual average rainfall of 1,280 millimetre in the city area of 174 sq km, the annual rainwater harvesting potential is about 222 billion litres, which means 608 MLD. The city's water demand is 880 MLD. There are two aspects of RWH: lakes in the open areas and rooftops in built up areas.

Rooftop-spin

After the severe drought of 1992 and 1993, Metro Water began a actively promote RWH. It worked out a 'statutory understanding' with the Madras Metropolitan Development Authority and the Chennai Municipal Corporation: they would accept building applications only if they included a proposal of RWH. But this was totally ineffective. Several approved buildings either lacked RWH systems or the structures were inadequate. A sample survey, conducted by the Madras Institute of Development Studies in 2002 at the behest of the Centre for Science and Environment (CSE), shows that of the 75 buildings approved for construction in 1997 and 1998, two-thirds had not installed any RWH system despite showing it in the map. In 1994, the state government made RWH compulsory for multi-storey buildings. In 2001, it became mandatory for all buildings. But people made RWH structures more to meet the building criteria than to solve their water crisis.

The state government then issued an ordinance in 2002, imposing a strict deadline for implementing RWH in all buildings. With chief minister Jayalalithaa embracing RWH with zeal, it has become a buzzword in Chennai, showing other cities the benefits of this time-tested system. This ordinance, claims Metro Water, has had such an impact that all the houses in Chennai have RWH.

A CSE survey in January 2004 found 86 per cent of the households had implemented RWH. (The survey also found

RWH structures in the most improbable place: a paddy field

that Chennai residents opted for a small percolation pit with a shallow borewell merely to meet the legal requirements.)

Shekhar Raghavan of Akashganga Trust, an NGO in Chennai, conducted a household survey on the effectiveness of RWH in Gandhinagar area from June to October 2003. It covered 309 independent houses and found that only 50 per cent had implemented RWH properly. The parameters he looked at included system implementation, apportioning of water, design and maintenance of water to ensure silt removal.

"In many homes, RWH is not done scientifically, the surface runoff is not harvested," he points out. The CSE survey had also found that 65-70 per cent of the households implemented RWH with designs obtained from either a plumber or developed on their own, indicating lack of technical guidance.

While the government effort to promote RWH is commendable, it is clear that legislation by itself will not make any difference. It needs stricter enforcement. Civic/community groups have to take up its monitoring and implementation. The RWH imperative has not got woven into the social fabric. But not all people have to be goaded into RWH.

A citizen's effort

K Venkatraman retired from the army and came back to his house in Padmanabhanagar in Adayar. His found the public supply inadequate, the groundwater brackish. As president of the residents' welfare association, Venkatraman initiated RWH in 1999, much before Jayalalithaa made it mandatory across the state in 2003. He began by installing a simple PVC pipe to divert rainwater. Several others in the 110-house colony followed his example. "Even during the worst crisis, water was available in borewells in our houses at 10 metres," he beams. The groundwater level in the neighbourhood has increased to a comfortable level and only a few households had to purchase water during the drought this year, while adjacent areas depended heavily on private tankers during the summer. "The annual potential of harvesting water in these 110 homes is to the tune of 14 million litres," says Venkatraman.

But the fuss over rooftops has taken attention away from the traditional way of recharging aquifers: maintaining lakes and tanks. Chennai has about 200 lakes, including about 35 temple tanks. Constant depletion of groundwater, encroachment of the lakes' catchment, and diversion of inlets has rendered most of these waterbodies dry. Tanks like Pallikaranai and Ambattur are endangered. The main threats: the housing board and the municipality.

In the city's rush to grab water from waterbodies far and away — the Veeranam lake, Krishna river — Chennai's waterbodies have been forgotten. The Citizen Consumer and Civic Action Group (CAG), an NGO, holds the Tamil Nadu Housing Board responsible for destroying several lakes. CAG filed a public interest petition against the board, but by the time the case was heard, the lakes had been filled up. About 58 hectares (ha) of a lake in Ambattur were taken over by the board for a housing project. Three-fourths of the Chittilipakam lake has been taken over. Around 18 ha at Kakallur lake have also been eaten up, says Bharath Jairaj of CAG. At Velachery, eight ha of Lakeland have been filled up by the slum clearance board and the housing board, he adds. The Pallikarani marsh, once a large nesting ground for birds, is now a 120-ha dump yard. The government might be keen on rainwater harvesting, but it has destroyed Chennai's waterbodies.

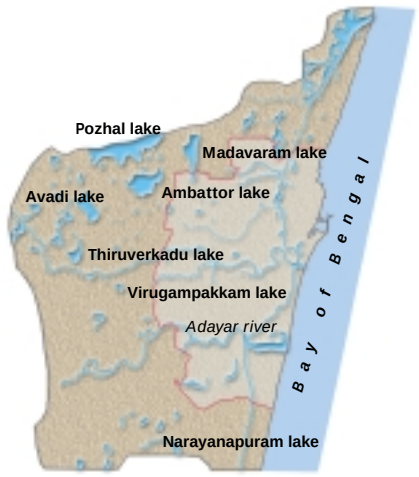
Desecrated temple tanks

The A M Murugappa Chettiar Research Centre, an NGO, surveyed 36 temple tanks in Chennai. Their aggregate storage capacity of 0.5 million cubic metres is sizeable, and can make a significant difference to groundwater recharge in the city. But most are dry or get only limited inflows; several are in a state of disrepair — broken sidewalls, water hyacinth infestation, silted tank beds. Most tanks are used as public conveniences for garbage disposal. The NGO suggests the following:

- desiltation
- reconstruction of the boundary wells and, where possible, increasing their height
- identification and removal of impediments to inflow of runoff; and
- measures to increase the rate of percolation into the ground.

But it is an uphill task to ensure that even as storm water drains are desilted and kept clear, sewage does not contaminate the water inflow. Along with these measures, local communities need to be mobilised. There are some good examples.

Chennai's water holes



Pammal tank

After successfully implementing RWH in their houses, about 1,000 residents of the Pammal locality have now moved on to restore their temple tank. "Once we began the desilting and cleaning operations, lots of people came forward to help in different ways like technical advice, monetary help or voluntary labour," says Indra Kumar, a Pammal resident.

The first to draw attention to the pathetic state of the lakes was Mangalam Balasubramanian, head of the Pammal Ladies Club. This led to the club holding a fund-raising campaign. Its members went from door to door. About Rs 13 lakh were raised. More than half of the fund went to strengthen the banks of the tank by constructing a wall around it. Residents are happy with the results. "In May 2004, we had 3.5 metres of water as compared to 1.2 metres in 2003," says Indra Kumar. Both the quality and quantity of water in the region has improved after the tank's restoration.

There are several tanks that can be transformed in a similar manner. "Desilt the 600 lakes in Chennai, Chengalpattu and Thiruvallur districts or construct check-dams along the Adyar and Cooum rivers to solve the water crisis," reckons V Subramanian, president of Water Bodies Protection, an NGO.

Taste for waste

Sewage, industrial effluent is the future

Chennai Metro Water claims that no less than 98.6 per cent of the city is connected to the sewerage. If the rainfall (and consequently the water supply) is normal in Chennai, it generates 300 million litres per day (MLD) of sewage. It has a treatment capacity of 262 MLD, but the treatment is only up to the secondary level. Of this 27 MLD is sold to industrial units in Manali, where it is further treated and processed for use. 262 MLD of sewage is treated in four major and one small treatment plant. The major plants are: Koyembedu (treats 34 MLD), Nesapakkam (23 MLD), Perungudi (45 MLD) and Kodungaiyur (160 MLD). Four waterways traverse the city. They are: Buckingham canal, Otteri Nallah, and Adayar and Cooum rivers. These are all eyesores at present. They have been reduced to conduits of sewage and industrial effluents.

The flat rate of Rs 50 that Metro Water charges domestic consumers includes water supply and sewage disposal charges. “In addition, a water supply and sewerage tax is collected once in two years. It comes to about 7 per cent of the rental value of the property,” says Madhavan Murthy, the utility’s chief engineer.

Metro Water claims only 17 per cent of the city's sewage is untreated. One visit to the waterways nails their lie. Even the Central Pollution Control Board points out the level of biological oxygen demand (and indicator of pollution) in the Cooum river is 480 milligramme per litre (mg/l) as against the maximum permissible limit of 3 mg/l. Why does Metro Water lie? Well, it doesn't know for sure the amount of water Chennai uses. How will it calculate the amount of sewage?

Chennai has 4.46 million people. If it is assumed that the water consumption is 200 litres per capita daily, the amount of sewage can be estimated at 700 MLD. The amount of untreated sewage, hence, is 448 MLD, which is 63 per cent of the total sewage — and this assumes that all the treatment plants are operating at full capacity. No wonder Chennai's waterways are repulsive to the eyes and the nose.

If Chennai collects and treats its sewage and reuses it (for non-potable and industrial uses), a sizeable chunk of its demand can be met. The treatment plant at Kodungaiyur sells 27 MLD of treated sewage at the rate of Rs 8 per kilolitre — a competitive cost. The daily demand for water is 880 MLD. The 700 MLD of sewage can help meet this. The state government has recently shown an inclination to this. Two major industrial units, Chennai Fertilisers Ltd (CFL) and Petroleum Corporation Limited (CPCL), have installed a tertiary sewage treatment plant each. These will use sewage supplied by the Kodungaiyur sewage treatment plant, which treats it up to the secondary level. The capacity of these plants is 11 MLD and 22 MLD respectively.

An industrious effort

Industry in Chennai has little, if any, dependence on Metro Water. Most industrial units rely on their own borewells or buy water from private operators. But some large units, such as Ford India Limited, Hyundai Motors Limited and Ennore Thermal Units, consume large quantities of groundwater and surface water. Partly treated sewage can provide for several industrial uses, should willingly switch to using such water.

Chennai’s water scarcity is an impermeable problem for industry. Most units have effluent treatment plants to reuse wastewater for gardening or cooling. Some units are more daring. CPCL and CFL have started buying partly treated

sewage from Metro Water, which they further treat for use as raw water.

CPCL buys 9.45 MLD of partly treated sewage from Metro Water at the rate of Rs 8 per kilolitre. CPCL uses a zero-discharge plant that not only helps convert sewage water into process water but also treats the effluent. "Earlier, we used to discharge our industrial waste into the Buckingham canal. Now, we do not add to the pollution of the city. We reuse every litre of sewage," says a CPCL official.

The company is a pioneer at sewage treatment — its efforts began in 1991. At its treatment plant, the sewage is settled in huge ponds, aerated to reduce organic pollutants and pumped through filters to remove chemicals. The water is finally pumped under high pressure through imported membranes in a reverse osmosis unit. CPCL's zero-discharge water treatment plant was inaugurated in March 2004. Its capacity is one million litres a day, and it uses membranes developed by CPCL in collaboration with the Central Salt and Marine Chemicals Laboratory in Bhavnagar, Gujarat.

"We undertook the project to develop commercial size membranes matching the performance of imported membranes," says a CPCL official. The Rs 60 lakh project was funded by the Indian Oil Corporation. The zero-discharge plant recovers 75 per cent of the water from the sewage. The technologies adopted by the CPCL can be of use to other water-intensive industries as well as public water supply units for recovering potable water from brackish water, the official added.

Reuse, recycle

Or relocate

"Shift Chennai to the vicinity of the Cauvery river," says K Karunakaran, director of the Centre for Water Resources (CWR) of the Anna University, which advises the government on water issues. This preoccupation with a perennial river — that can supply water round the year and carry off the city's sewage — is at the heart of Chennai's incomparable water crisis. The political leaders of Tamil Nadu have desperately searched for that elusive river. They have tried to tap into the Cauvery and the Krishna. These efforts have failed because there are several uses for the limited water available, irrigation most notably. In purely environmental terms, irrigation is a better use of water as it plays a role in recharge of groundwater.

Tamil politicians will just *have to* accept the fact that peninsular India doesn't have snow-fed Himalayan rivers. And even the metropolitan cities of northern India, spoiled for choice by large rivers and high annual rainfall, are desperate for more water and are doing what Chennai is doing — tapping sources far and away. Large rivers like the Ganga and the Yamuna have been reduced to sewers. While Chennai's desperation is far greater than theirs, they are fast getting there by managing their water and sewage mindlessly.

Chennai is an example — a warning for other cities as well as symbol of tenacity. The city takes rainwater harvesting (RWH) more seriously than any other, though there are several problems in implementation. RWH from rooftops can be successful only if it is part of a social movement rather than a government diktat. But rooftop RWH, even if implemented properly, is a small part of the bigger solution. The centrepiece of RWH in Chennai should be its 200 tanks and lakes. These are essential to maintain the health of the city's groundwater that is fast declining and turning brackish. But instead of keeping these clean and ready to store water for around the year, the government treats these waterbodies as garbage sites. The government's housing board is using their beds and catchment to construct housing colonies. People will live where water once was. Obviously, they will not get water.

As for the three major reservoirs that have sustained the city for decades, 40 per cent of their water is lost due to evaporation. Aegis Chemical Industries Ltd, a company in Jalgaon, Maharashtra, spreads a blend of saturated fatty alcohols on a waterbody to prevent evaporation losses. Karunakaran of CWR will do well if he can direct his institute to find solutions to cut these losses, instead of talking about quixotic ideas like shifting the city.

Chennai needs to re-focus. For example, water from desalination plants will cost Rs 50 per kilolitre. If the city instead invests in effective sewage treatment, the water will cost only Rs 3 per kilolitre. This can be used for non-drinking uses or groundwater recharge. The Union government has allocated Rs 1,000 crore for desalination. Chennai needs to recalculate its costs and prioritise investments. "Desalination should be the hundredth option," says S Janakarajan, professor at the Madras Institute of Development Studies.

Chennai's water strategy will be realistic only if it accepts its location and ecology. Hydrologically, it is a city at the tail end — beyond it is the sea. At some point, it will have to end its search for a perennial river or water sources hundreds of km away or expensive desalination plants. It will have to look at its waterbodies, its sewage. It is possible, given the city's desperation. If it does, it will show other Indian cities the way to the future, because every city is a tail end for water and the source of sewers. If Chennai can't do that, then it can begin its relocation plans. ■


IF YOU GIVE US SOME OF THAT, WE CAN GIVE YOU SOME OF THIS!
WATER
TRUST
INDUSTRY
COMMUNITY


WATER?... YOU HAVE COME HERE TO LOOK FOR WATER?

There's nothing august

JULY 26, 2005: It began raining at 11 am. In the next 24 hours, India's most populous city received 944 mm of rainfall. The resultant flood killed 450 people (officially), and caused financial damage worth about Rs 4,000 crore. For three days, the water didn't recede.
AUGUST 2005: Fever, malaria, dengue, leptospirosis, diarrhoea, cholera. Inquiries, press conferences, public hearings, committees, commissions, terms of reference. Mumbai is back to normal. But Mumbai is asking: how did it happen? Why? NIDHI JAMWAL examines these questions in great detail.

The flood was foretold. The disaster, in all its dimensions — perhaps not the scale — was already mapped. For years now, Mumbai's politicians — of all hues — have ignored the signs: the crumbling drainage system; the built-over natural drainage; the poisonous landfills where garbage stands 8-10 metres high, exuding poison; the untreated sewage, shamelessly dumped into the Arabian Sea.

Post 26/7, will anything change? Might not. For like the flood, one kind of future for the city has also been foretold. Says *Transforming Mumbai into a World-Class City: First Report of the Chief Minister's Task Force*: "Our vision is for Mumbai to possess, by 2013, the twin elements of a world-class city: dynamic, job-creating growth and a comfortable quality of life. Our ten-year vision is for Mumbai to be globally distinctive in economic growth and healthcare, and to be in line with global best practice in other parameters like housing and transportation."

Greater Mumbai (GM) is an amalgam of 11 islands reclaimed and connected over 100 years or so; seven islands comprise the City and four the suburbs. Spread over 468 sq km, with a population of over 13 million and a population density as high as 27,120 per sq km, India's most populous city has slums that accommodate, the 2001 census says, over 49 per cent of the population — one in two persons.

GM falls under the jurisdiction of the Municipal Corporation of Greater Mumbai (MCGM), responsible for its planned development and basic infrastructure. But there also exists the Mumbai Metropolitan Region Development Authority (MMDRA), under the state's urban development ministry; its job is to develop the entire 4,355 sq km Mumbai metropolitan region (MMR), which includes GM. The former is with the Shiv Sena; the state government — Congress-NCP — controls the latter. Thus, jurisdiction is always a political scuffle. Moreover, "On the one hand, the act governing MCGM is as old as 1888; on the other, MMRDA has acted more like a real estate agency than a planning body. Initially, it had no justification to exist; then, it started its business by reclaiming Mithi's wetland and selling plots at the Bandra-Kurla complex," says Shekhar Krishnan, executive member of Mumbai-based Collective Research Initiatives Trust.

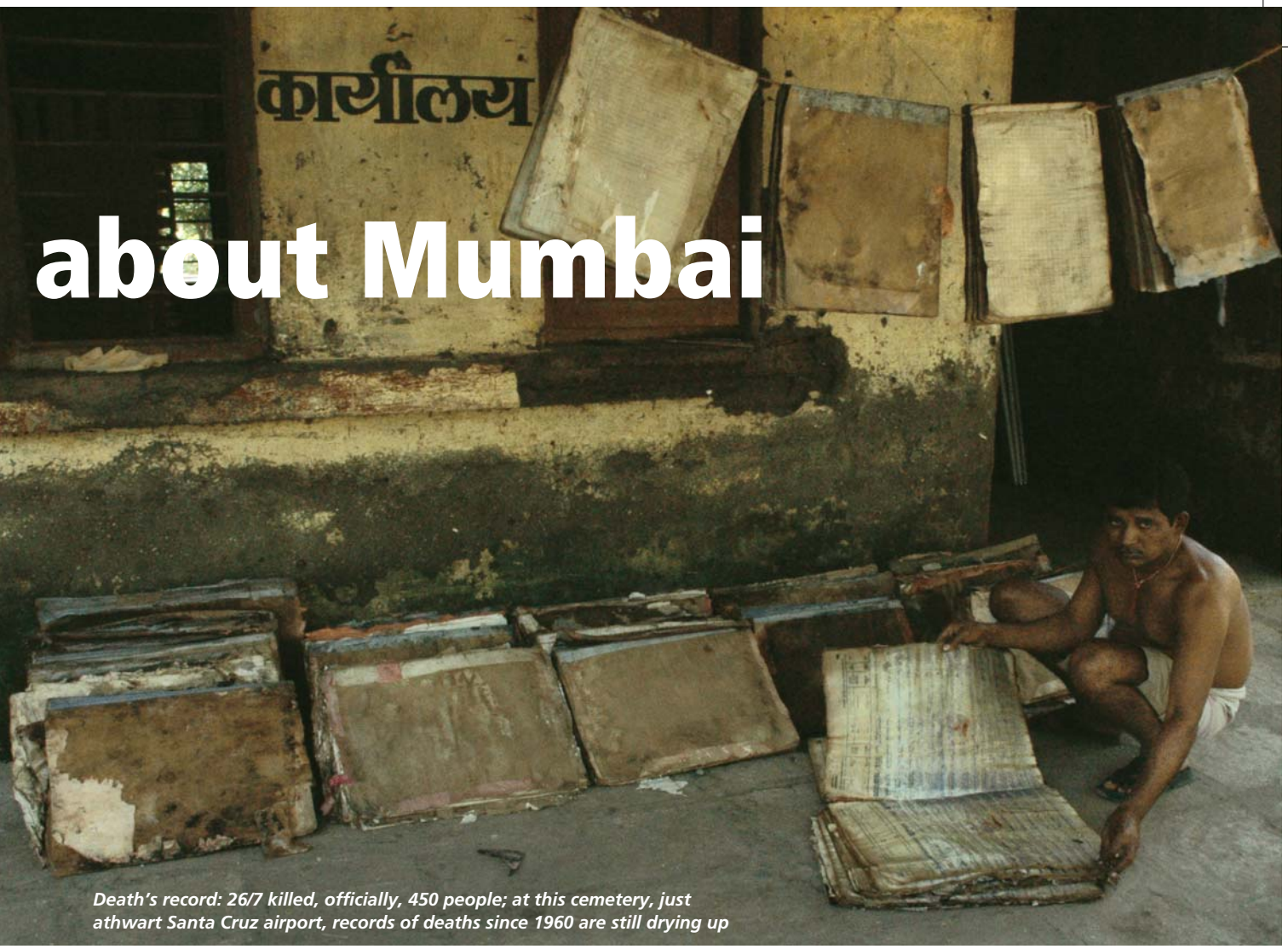
In 1996, H P Samant, a geologist teaching in St Xavier's College, Mumbai, completed an in-depth study that showed Mumbai was heading for built-up disaster. In 1925, 60 per cent of land in Mumbai was forest/agricultural land. By 1994, this had shrunk to 30 per cent. 1925-1994, mangrove jungles reduced from 28 per cent to 18 per cent. In the same period, the built-up area shot up from 12 per cent to 52 per cent (see maps: *Built-up and choking*).

Samant's study highlighted how the six basins of various streams that criss-crossed Mumbai and flowed into four creeks were turned into roads, buildings and slums. The Mithi river basin suffered the most (see table: *Built up*).

1996-2011: a daft regional plan

The latest statutory development plan for the MMR is prepared by the MMRDA and is called the *Draft Regional Plan for Bombay Metropolitan Region, 1996-2011*. It has turned the planning process into anarchy.

The 1973 regional plan for the Mumbai Metropolitan



about Mumbai

Death's record: 26/7 killed, officially, 450 people; at this cemetery, just athwart Santa Cruz airport, records of deaths since 1960 are still drying up

PHOTOGRAPHS: DEBOJYOTI KUNDU / CSE

Region was the current plan's precursor. It recommended Greater Mumbai's population be restricted to 7 million. It said new industries, offices and commercial establishments not be set up. The current plan acknowledges that "20 years after [the 1973 Plan], Mumbai continues to reel under poor infrastructure and high level of environmental pollution". But this acknowledgement is rhetorical. For, it also says the approach "is to facilitate their [cities like Mumbai] development through provision of infrastructure, and by removing any obstacles in the path of their economic progress…". According to the 1996-2011 plan, cities like Mumbai have "important role as generators of national wealth". Plan 1996-2011 also demands permission to adopt land-use policies that respond to market potential.

The plan is downright controversial. It recommends dumping of waste in low-lying areas along creeks; this "will result in possible trade-off". The plan says: "… it will be appropriate to allow salt pans, which anyway are not wetlands in their natural state, to be used for… critical urban uses…". Explains Samant, "This is ridiculous. It is technically wrong and has no ground in a court of law. Who says saltpan lands are not wetlands? Wetlands are all those areas where seawater intrudes when there is a high tide." Further, Maharashtra has slyly added a new category of saltpan lands as 'saltpan land not in coastal regulation zone', which, claims Samant, needs to be questioned in the court of law. Builders are demanding control of saltpan lands adjacent to Mumbai; they wish to house the poor there. Even the chief minister's task force February 2004 report on *Vision Mumbai: Transforming Mumbai into a world-class city* says slum dwellers can be moved to the "saltpan lands" and to the "current No Development Zones (NDZ)". Even after the July 26 deluge, chief minister Deshmukh said in a press conference that "NDZ does not mean never development zone" and that dereservation can be done "in larger public interest".

The state government seems hell-bent on further congesting Mumbai, with global expertise. *Vision Mumbai: Transforming Mumbai into a world-class city* was jointly prepared by international consultant McKinsey and Co and elite NGO Bombay First (it was presented in 2003; subsequently, the chief minister set a task force to look into it) is a blueprint for Mumbai's overall development over the next 10 years. For this "Mumbai must invest US $40 billion": "Several cities (Cleveland, Shanghai) have been eminently successful… and if Mumbai were to follow…[in terms of investment worth billions of dollars] it, too, will be well on its way." At an *International Conference on Urban Renewal: Learning for Mumbai* — held May 24-26, 2005; finance minister P Chidambaram inaugurated it — a bureaucrat proposed Rs 35,000 crore worth infrastructure projects, perhaps taking cue from the report. A part of money for the makeover *Vision Mumbai* envisages, hopes the state government, will come from the recently announced National Urban Renewal Mission, which has a budgetary allocation of Rs 6,500 crore for 2005-2006.

What do experts think? "We cannot allow further congestion of Mumbai by all these swanky infrastructure projects. This is highly unsustainable," says R N Sharma, Unit for

We cannot allow further congestion of Mumbai by all these swanky infrastructure projects

Urban Studies, Tata Institute of Social Studies (TISS), Mumbai.

Development 'tools'

Mumbai is already built to bust. But government claims it has development 'tools' that also 'uplift' the poor. The most famous 'tools' are: floor space index (FSI), transfer of development right (TDR) and additional development right (ADR). All three are very builder-friendly. Another 'tool' is reclamation — reclaim the sea, reclaim riverbeds or build on land that gets exposed during low tide.

FSI is the ratio between the built-up area allowed and plot area available. So if FSI is 1, then on a plot of 100 square metres (sq m), one can build 100 sq m of built-up area; with setbacks and open spaces, the building can be higher than one floor. Simply put, the higher the FSI, the more the floors. In Mumbai, the City has an FSI of 1.33, near suburbs have an FSI of 1 and distant ones, 0.7.

Related to FSI are TDR and ADR. TDR is the right to transfer development of a plot to another one. For instance, if a plot-owner for some reason is not allowed to use up the entire FSI of 1.33 in the City, s/he can use the remaining FSI on another plot, or sell it in the open market. ADRs are issued to rehabilitate slums, or re-develop old buildings such that the profit generated will be used to re-develop/rehabilitate slums.

Builder 'tools'

Krishnan claims FSI is a money-making tool; it has no relation to planning. During elections, Mumbai is showered with a lot of increase in FSI and dereservation of open plots, he adds. Otherwise, too, government often increases FSI at the drop of a hat. When it comes to re-developing old buildings, reconstructing chawls or housing the poor, increase in FSI is a favourite tool. In this way, huge land-use changes are taking place in Mumbai without people knowing about it. Even dereservation of open spaces isn't publicly debated. "Near my house in Parsee Colony, Dadar, land was reserved for a secondary school and a playground, but to my utter surprise skyscrapers are coming up there. Another such vacant plot in Bandra Reclamation area was reserved as an open space for residents, but without people's knowledge it was transferred to Sports Authority of India. Local people have gone to the Bombay High Court to protect their open space," says Krishnan.

Samant claims that the 1991 coastal regulation zone (CRZ) law, too, is being twisted by politicians and builders. "Mumbai falls under the CRZ II zone, which is measured 500 m towards the land from the high tide line. The aim of this zone is restricting construction activities to control further densification. This zone also has a special provision for a buffer zone wherever there is seawater intrusion through creeks or natural channels of the creeks. On both sides of such natural channels, a buffer zone measured from the high tide line has to be maintained. In this zone, FSI is also restricted. But politicians and builders merrily calculate buffer zone from the low tide line or from wherever it suits them. The only hope for Mumbai is to implement the CRZ law," says Samant.

Till recently, Samant was a member of the Maharashtra State Coastal Zone Management Authority. He acknowledges that, till date, not even a single person has been booked under CRZ law, though violations are aplenty.

Milling for land

The central part of Mumbai is dotted with the remains of over 50 textile mills, about 2.4 million sq m (243 ha) of land that, experts claim, can be used in a planned way for Mumbai. But the state government has ensured that while politicians, mill owners and builders amass wealth, Mumbai chokes on.

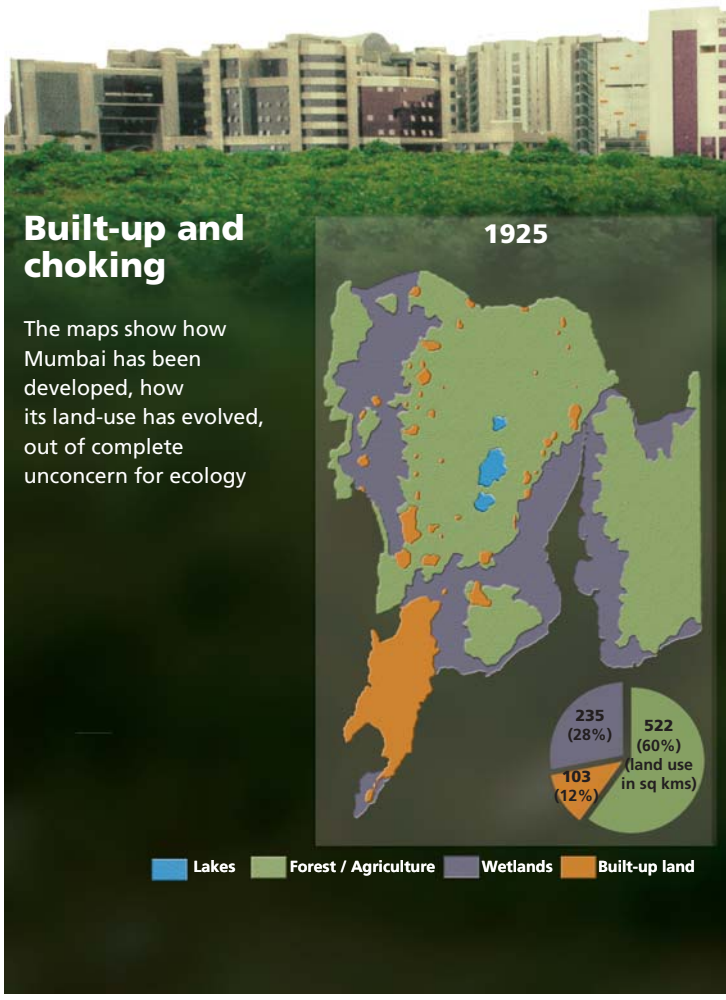
In the state government's *Development Control Regulations*

Built up

Building upon the natural drainage system

Basin flowing into	Area (sq km)	Built up area (percent)
Vasai creek	8.98	43
Vasai creek	27.2	10
Manori creek	37.44	18
Malad creek	16.56	49
Malad creek	24.21	50
Mahim creek	42.07	54

Source: H P Samant, senior lecturer, department of geology, St Xavier's College, Mumbai

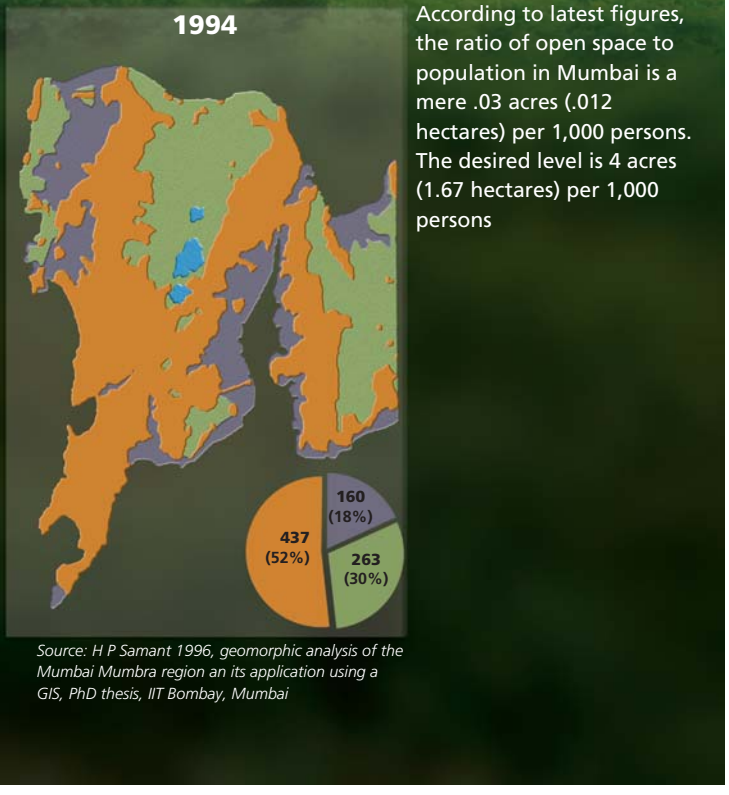


(DCR) for Greater Bombay, 1991, there existed DCR-58. By this rule, owners of sick mills had to surrender one third of the mill land to the MCGM for public amenities. An equal portion had to be given to the housing authority for social housing. The mill owner could develop the remaining one third or sell available FSI in open market. But in 2001, Deshmukh surreptitiously amended the DCR-58 in favour of mill owners. They could keep the present built up mill area (almost 80 per cent of total mill land) and share only the non-built area with the city.

Post-2000 saw major construction activity in the mill lands. Huge shopping malls came up right in the heart of the city. In the course of a public interest litigation filed in this regard, the city realised that what the chief minister had done. Mumbai lost out on more than 140 ha of land — its share as open spaces and public housing. As per the latest calculations, Mumbai will hardly get 8 per cent of the mill land for open spaces. The rest goes to mill owners, selling mill land like hot potatoes. Is it a coincidence that politicians like Manohar Joshi and Raj Thackery paid a premium price of Rs 421 crore to bid for Kohinoor Mills?

Further, it has recently come to the notice of the Bombay High Court, which is hearing the matter, that many mills had started construction work without taking necessary permission from the pollution control board. As per the court's directions, the Maharashra Pollution Control Board has recently issued stay orders to mills carrying out illegal construction. But the issue is far from resolved.

Mumbai seems to have lost a golden opportunity to create its lungs in the form of open spaces from the freed mill lands. How can it live? That is a question only politicians can answer.



According to latest figures, the ratio of open space to population in Mumbai is a mere .03 acres (.012 hectares) per 1,000 persons. The desired level is 4 acres (1.67 hectares) per 1,000 persons

Source: H P Samant 1996, geomorphic analysis of the Mumbai Mumbra region an its application using a GIS, PhD thesis, IIT Bombay, Mumbai

Let Mithi flow

Why did it take more than three days for water to drain out of Mumbai?

The government said: high tide water, acting like a wall. Rubbish. The tide, on July 26, was at its highest at 15:50 hours, just four and a half hours after it had started raining; in the next three days, it did not peak much (see table: *Tidal lie*). So what went wrong? On July 27, at a press conference, Vilasrao Deshmukh thundered: "Too much rain, drainage not at fault". But Mumbai's stormwater drainage network (SWDN) is over 70 years old. "The British constructed it to handle run-off capacity of 25 millimetre (mm) per hour at low tide, just by rule of thumb. It is now 2005. Mumbai's population has exploded and the built-up area has increased rapidly. Also, the monsoon pattern has changed. But the drainage system has only crumbled," laments Kapil Gupta, professor at Indian Institute of Technology Bombay, Mumbai.

According to the Municipal Corporation of Greater Mumbai (MCGM), Mumbai's 'official' SWDN consists of road drains, minor *nullah*s, major *nullahs* and outfall. All are interlinked, and finally empty into either the Arabian Sea directly or into the four creeks that open into the Arabian Sea.

The City is extremely privileged. It has 115 SWD outfalls. In contrast, the Western suburb has 43 and the Eastern suburb a paltry 28 — the Mithi river carries most of the discharge from these. Also, the City system is mostly underground; the suburbs have open drains and *nullah*s. "Suburbs are developing so rapidly that the municipality is not able to provide proper drainage. Also, low-lying areas and old ponds have been filled to make multi-storey buildings and shopping malls. So the natural drainage system, of holding ponds and water channels, no longer exists. Flooding is but natural," says R N Sharma, head of unit for urban studies, Tata Institute of Social Sciences (TISS), Mumbai.

The suburban outfalls depend on gravity to discharge rainwater: flood gates — which close when the tide reaches 4.6 m high, or in heavy rainfall, to avoid a seawater backflow — are located only at Love Grove, Worli; Cleveland Bunder, Worli;

Tidal lie

Highest and lowest tides, July 26-29, 2005

Date	Time (hours)	Height of tide (metre)
July 26, 2005	1550	4.48
	2213	0.90
July 27, 2005	1631	4.14
	2258	1.06
July 28, 2005	1710	3.76
	2351	1.24
July 29, 2005	0644	3.43
	1214	2.40

Source: Mumbai (Apollo Bandar)- India, West Coast

and Haji Ali. This is why most low-lying suburban areas experience annual floods. Moreover, "At many places seawater has intruded into the city through stormwater drains and corroded pipelines. Sometimes it even shakes multi-storey buildings," says Girish Raut, a Mumbai-based activist.

All wrong: drainage

Mumbai's drainage problem is completely an effect of construction- and reclamation-mania. Explains Gupta: "The quantity of water falling on the city has not decreased, but the space to flow has, tremendously. Earlier, almost 50 per cent water would seep into the ground, drastically reducing the total volume to be managed. But today the whole city is cemented. Hence, whenever water falls, the ground cannot absorb it. Most *nullah*s and drains are encroached upon and choked. They, too, cannot tackle so much water."

There is no local practice of stormwater management. At present, every municipality in India must follow the 1993 *Manual on Sewerage and Sewage Treatment* of the Central Public Health and Environmental Engineering Organisation (CPHEEO) under the Union ministry of urban development. "The CPHEEO manual prescribes a single capacity — of 12 mm to 20 mm per hour flow — for SWDN throughout India, be it Jaisalmer or Mumbai. This is ridiculous. It needs to be updated," says Gupta.

An SWDN in any Indian city is today constructed keeping in mind peak per hour flow. Gupta believes this doesn't make sense. All calculations, he says, need to be made on the basis of 15 minutes peak flow, for in any Indian city, on average, it takes about 15 minutes for water to flow — from where it falls — to the nearest drain.

Any ideas?

MCGM conducted an elaborate study of Mumbai's drainage system in 1992. The Brihanmumbai Storm Water Drains (BRIMSTOWAD) report recommended the following: divert dry weather flow to sewage pumping station; provide storm water pumping stations; increase drain capacity; improve floodgates; repair dilapidated drains; augment railway culverts; and deepen/widen *nullah*s. At that time the cost of the project, to be implemented over 12 years, was Rs 616 crore. This has now escalated to Rs 1,200 crore. Some work was started. Then everything stopped, due to lack of funds. Surprising: MCGM is one of the richest municipalities in the country, with an annual budget of about Rs 7,500 crore.

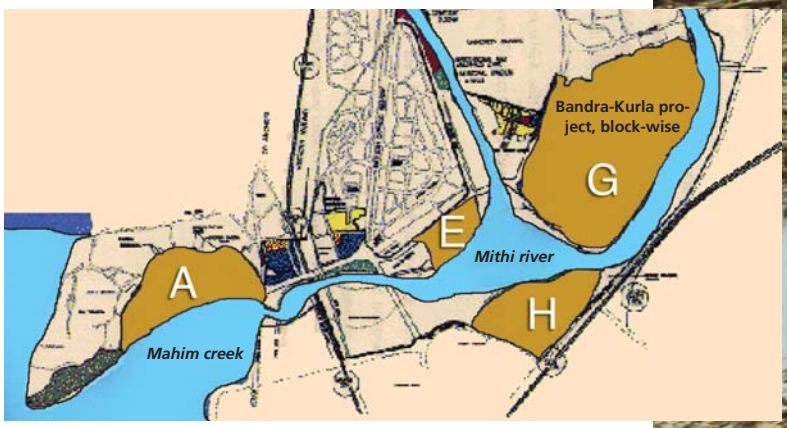
Post-July 26, the state government has forwarded BRIMSTOWAD to the Centre, which now seems in a mood to fund the project. If implemented, the capacity of Mumbai's SWDN will increase from 25 mm per hour to 50 mm per hour. Will that solve the problem? "No. The situation has changed since 1992, when BRIMSTOWAD was prepared. 50 mm per hour is still under-capacity. What Mumbai needs is minimum 100 mm per hour capacity drains," suggests Gupta.

What about natural drainage?

The most ignored system in Mumbai is its natural drainage, its rivers and rivulets. Of these, river Mithi is the most important, drainage- and ecology-wise. Others have almost disappeared; the Mithi still flows as a stinking choked *nullah*.

The river originates in the Sanjay Gandhi National Park — thus, it is rain-fed. It flows to the Tulsi lake, and thence to Vihar and Powai lakes. From Powai lake starts an approximately 15 km journey that ends in the Arabian Sea at Mahim creek: in other words, all of north Mumbai forms the Mithi's catchment.

Now consider official awareness. Some plans prepared by the Mumbai Metropolitan Region Development Authority (MMRDA), Mumbai's chief planning body, do not even show the river. Reads the MCGM's *Environmental Status Report of Mumbai 2002-03*: "One of the heavily polluted *storm water*



In the July 26 deluge, a swollen Mithi river burst through the walls of the Santa Cruz airport. The airport has been built on what was once a wetland the river created (right). An index of how developers treat the city's natural drainage system is the Bandra-Kurla project, four blocks of which are shown on the map below: all of these suppress the river

Ignored

Two studies warned: Mithi was a disaster waiting to strike

1996: National Environmental Engineering Research Institute study

- Mahim bay at present receives around 146 million cubic metres (cum) of untreated sewage per annum ... through Mithi river ... Bandra-Kurla Complex (BKC) ... would generate over 10 million cum of sewage per annum, which would further add to the critical pollution levels
- Dissolved oxygen levels are in the range of 1-3 mg/l during high tide which reduces to zero, creating stinking anaerobic conditions, during low tide
- No environmental appraisal has yet been carried out by the MMRDA, nor sought by the Government of Maharashtra/ Ministry of Environment and Forests
- The mangroves at the proposed site of BKC Block G were destroyed during 1994-96
- MMRDA ... has put the region's ecological wealth towards the path of irreversible ecological damage
- The reclamation of wetlands and mangrove swamps in Mithi river estuary would increase flooding potential in the region, which is already a recurrent annual phenomenon on the Mumbai coast line
- The site for International Finance and Business Centre (BKC Block G) and parts of other blocks are within the intertidal zone, which is in violation of the Coastal Zone Regulations

2004: Findings of Maharashtra Pollution Control Board

- Pollution levels have reached an alarming stage
- [Some] samples... had very low or nil dissolved oxygen probably due to high organic load contributed by sewage or decomposed garbage
- Oil & grease levels were very high (more than 10 mg/l) at most locations starting from Powai lake overflow to Mahim creek
- Dissolved oxygen ranges between nil and 2.5 mg/l
- Total dissolves solids range between 943 to 35,252 mg/l
- Chlorides range from 372 to 21,238 mg/L
- Chemical oxygen demand 92 to 358 mg/L

drains, known as Mithi River, is responsible for *polluting* Mahim Creek (emphasis added)."

Big fish play with it

Post July 26, the government is talking of removing slums, for — it claims — these have polluted the river. But slums are minnows. The big fish is the Bandra-Kurla Complex (BKC), government's own creation. BKC has been built mostly on reclaimed Mithi wetland and by destroying mangrove jungle.

Various reports had warned against reclaiming the wetland (*see box: Ignored*). In 1993, the mangrove committee of the state government said reclamation would obstruct Mithi. In 1996, the National Environmental Engineering Research Institute (NEERI) exposed MMRDA's malfunctioning. Next year, the Bombay Natural History Society did a study for the Union ministry of environment and forests (MOEF), in which it recommended in-situ protection of Mahim mangroves. Still, the BKC project went on.

In 2003 and 2004, architect P K Das and the Maharashtra Pollution Control Board prepared action reports on Mithi's revival, to no avail. The only study supporting BKC's construction was one completed in 1996 by Pune-based, government-owned Central Water and Power Research Station (CWPRS), which NEERI alleges is a "limited study". Experts contend that data as old as 1938 and 1954 was used to justify reclamation.

BKC is criminal engineering (*see map*). "G block of BKC has directly suppressed Mithi, changed its course of flow and ensured that no mangrove survive there. Bund construction has blocked tidal water flow," says Raut.

Other fish, too

Air India colony in Kalina and the Santa Cruz airport, that got badly inundated on July 26, are also built right on Mithi wetland, which once stretched from Kalina till Mahim Creek. But this has been reclaimed for construction. For instance, Airport Authority of India (AAI) reclaimed land to construct a runway and changed the river's direction by constructing a wall — the river now runs in two right angles while passing near the airport! On July 26, the swollen river breached the wall. "Our houses, and death records post-1961, all got washed away," says Shanta Ram, who performs last rights of dead bodies in a Hindu cemetery right behind the Santa Cruz airport. "Without any doubt I can say it is this wall that has changed the course of Mithi and narrowed its path. And we all have paid a price for messing with the river."

The state government claims it will remedy the Mithi's pollution and other problems. A Mithi River Development and Protection Authority, headed by the chief minister, has been set up. It will suggest corrective measures. Interestingly, none other than the MMRDA, the river's worst tinkerer, has to prepare a draft proposal to set up of this authority and also conduct a survey of the river. And CWPRS — which supported construction of both BKC and Bandra-Worli Sea Link — has to recommend remedial measures within the next two months. Good luck, Mithi river.

Dirty deal

Mumbai is wasting away, literally

Mumbai generates about 2,800 million litres of sewage daily, an official guesstimate. Experts believe the quantity is much higher, and remains unaccounted for. But what is the jewel in the sewage crown? Dumping untreated sewage into the sea. This operation masquerades as 'marine outfall'. "Marine outfall is a state-of-the-art system, which disposes of sewage three kilometres inside the sea through a pipeline running along the seabed. Sewage is dispersed at various points inside the sea for minimal pollution. These marine outfalls are capable of discharging sewage even during a high tide and their pumping capacity is five times the normal sewage flow," says D T Dange, chief engineer (sewage operation), MCGM.

MCGM has divided Mumbai into seven sewerage zones (see table and map: *Solid waste*). The sewerage network, over 1,400 km, comprises 41 satellite pumping stations and seven major pumping stations — one for each zone, each with their own sewage collection and treatment system. Sewage is collected in sewer lines through gravity and conveyed to satellite pumping stations. From here it is pumped to the main sewage pumping station (SPS). The SPS sends untreated sewage to a sewage treatment plant (STP) of a zone, for treatment and final disposal into the sea. MCGM, with financial support from the World Bank, is implementing an integrated water supply and sewerage project and has prepared a sewerage master plan till 2025. According to a recent paper, *Sewerage operations of MCBM*, by P R Sanglikar, deputy municipal commissioner, MCGM, the master plan is a five-phase programme (2005-2025) with a total cost of Rs 55,70.4 crore — Rs 39,45.15 crore for sewerage work and Rs 16,25.25 crore for slum sanitation. The plan is under implementation. Still, untreated sewage continues to flow into the sea. Why?

Marine outfall

Marine outfall is basically a conduit to dispose sewage into the sea after partial treatment. A typical marine outfall has an influent pumping station (IPS) and an effluent pumping station (EPS). The former discharges sewage in normal conditions; EPS comes into play during high tide.

Down To Earth visited Bandra IPS and EPS sewage facility. The facility is on reclaimed land near the Mahim creek. Stiff local opposition delayed the plant's completion by over two decades. But since May 27, 2003, it has been functioning.

The inflow of sewage here is about 600 million litres daily (mld); this increases during the monsoon. According to the sewerage operations department of MCGM the increase is due to rainwater inflow in sewer lines. But the municipality's stormwater division claims it is the raw sewage that mostly flows in the stormwater *nullah*s throughout the year and needs to be diverted to the SPS for proper treatment. "Before this facility began, untreated sewage was emptied out in the sea through various *nullah*s and Mithi river. But things have changed now and fish can be seen near the coast, proving the facility's success... . Although the normal flow of sewage is up to 600 mld, the total capacity of this facility is over 2,100 mld. This will take care of additional load for the coming 15 years in Bandra zone," says V P Pandey, assistant engineer, Bandra IPS facility. But things are not as rosy as MCGM would want us to believe.

Treated sewage?

Data from Bandra EPS facility (in mg/l)

Date		Inlet	Outlet*	MPCB standard
29.6.2005	BOD	130	124	100
	TSS	170	160	100
7.7.2005	BOD	146	146	100
	TSS	180	180	100
11.7.2005	BOD	160	147	100
	TSS	160	180	100

*All figures for outlet column exceed the prescribed limits
BOD: biological oxygen demand; TSS: total suspended solids; mg/l: milligramme per litre
Source: Data collected from Bandra EPS facility, MCGM, Mumbai, mimeo

The method

The treatment method followed in marine outfall facilities is rather incomplete. Firstly the floating matter (chiefly plastics) is removed using screen bars at IPS. Sewage is then pumped up to the EPS facility, where the floating materials are once more. "Plastics are a major problem as they form a wall against the screen bars and restrict sewage flow. This leads to grit settling in the first chamber itself, whereas it should settle in the next chamber. Grit up to 6 feet height has deposited in some chambers and we are physically removing it," says an engineer at Bandra EPS facility.

After screening chamber, the sewage enters the aerated grit chamber, where compressed air helps settle grit. MCGM engineers claim such aeration is tantamount to 'treatment'. The sewage is finally disposed off in the sea through a 3 km pipeline. The whole process, according to Pandey, takes eight hours. Both the floating matter and the grit is transported to Deonar dumping ground for disposal.

But is the present eight-hours-aerated-grit-chamber-treatment method effective for sewage treatment? Not so, if one goes by the data of MCGM's laboratory at Dadar. According to lab reports *Down To Earth* (DTE) chanced upon, the so-called treated effluent fails to meet prescribed MPCB standards (see table: *Treated sewage?*). This data is collected during the monsoon, when rainwater dilutes sewage. So what must the situation be in other months?

Lagoons any better?

The second method of sewage treatment MCGM uses is aerated lagoons. These lagoons are operational in Versova, Ghatkopar and Bhandup and follow a more elaborate treatment process. DTE visited Versova Waste Water Treatment Facility and Lagoons (VWWTFL), at Versova near Andheri. This facility, running since 1998 and built at a cost of Rs 34 crore, has a total capacity of 180 mld of wastewater and 90 mld for lagoons. This means: the facility can receive up to 180 mld of sewage, but the lagoons can treat only 90 mld. So where does the rest go? "We have no option but to bypass excess untreated sewage straight into the [Malad] creek," admits a MCGM official.

VWWTFL follows an exhaustive treatment process — physical treatment that removes floating materials and grit, and biological treatment in lagoons that removes organic matter. Lagoons consist of six ponds. The first two ponds are aerobic lagoons whereas the rest four follow both aerobic and anaerobic processes. These ponds consist of aerators, which help microorganisms present in the sewage digest the organic pollutants. The whole process takes about four-and-a-half days to complete," says Sagar Kharde, sub engineer, VWWTFL. The results indeed are encouraging, with BOD reduced to as low as 30 mg/l, TSS at less than 50 mg/l, and COD as low as 80 mg/l. Treatment cost is also low, at Rs 340 per million litres.

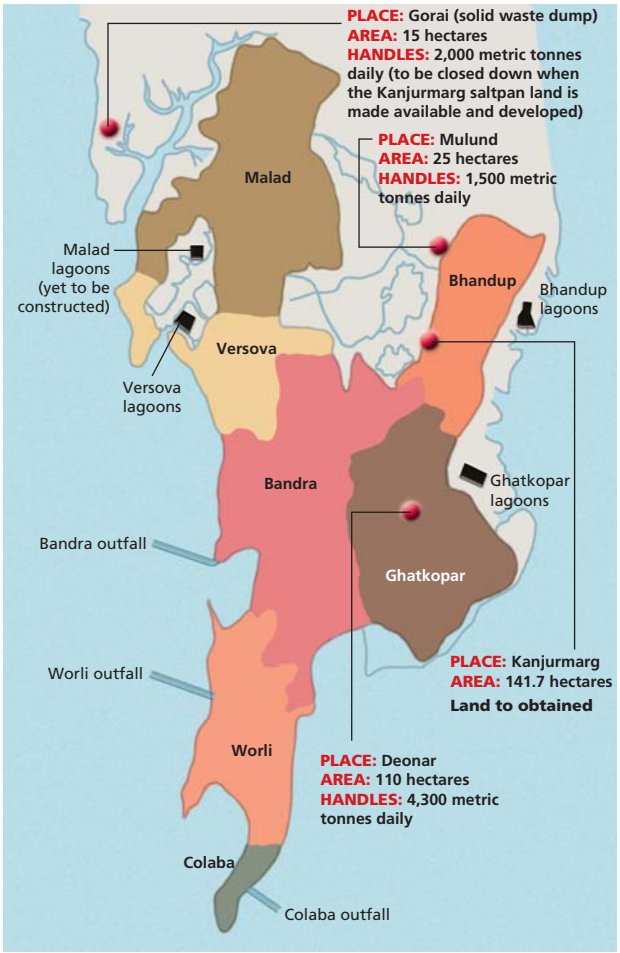
Solid waste

Sewage or pure garbage, Mumbai has no answers

Zone	Total area (ha)	Existing sewer lines (km)	Average dry weather flow (mld)	Final treatment
Colaba	574	32	41.10	Marine outfall
Worli	3,891	339	756.90	Marine outfall
Bandra	7,727	350	796.80	Marine outfall
Versova	2,143	149	180.00	Aerated lagoon
Malad	11,533	329	280.40	Grit chamber (lagoon to be constructed)
Ghatkopar	7,730	174	386.10	Aerated lagoon
Bhandup	4,274	110	230.00	Aerated lagoon
Total	37,872	1,483	2,671.30*	

*mcgm claims the sewage generation is 2,800 mld

Source: Kapil Gupta 2005, Continuing Education Programme Course on Urban Drainage Management: state-of-the-art 2005, Department of Civil Engineering, Indian Institute of Technology Bombay, Mumbai.



Composition of Mumbai's waste

Debris is the real problem

Nature of waste	Percentage of total waste	Quantity (tonnes per day)
Short-term biodegradable (food waste, vegetable waste)	30 to 40	2,340
Long-term biodegradable (paper products, coconut shells, textiles)	12 to 20	936
Recyclables (plastic, glass, metals)	8 to 15	624
Miscellaneous mixed waste including sand, silt, sanitary diapers	20 to 30	1,560
Debris and construction waste	30 to 35	2,340
Total		7,800

Source: Rakesh Kumar 2005, Waste management scenario in Mumbai: things can improve, *NEERI, Mumbai, July 15, mimeo*

But this is true only of 90 mld. What of the untreated 60 mld to 110 mld sewage? "MCGM has two options. Either to reduce the retention time for sewage treatment or to set up more lagoons. For the latter we need more land and there is hardly any free land in Mumbai. An entrepreneur has approached MCGM with a chemical whose addition, he claims, will reduce retention time from over four days to less than a day. MCGM is testing the chemical's efficacy," says a MCGM official on condition of anonymity.

The Versova facility faces other problems as well. The lagoon capacity is decreasing; one and half metre thick sludge has accumulated in the ponds that has not been removed since the facility started functioning.

Unofficial sewage

"The present sewerage covers only 60 per cent of Mumbai, leaving out slums and maybe some upcoming residential/commercial complexes. Efforts are on to provide sewerage facilities to these areas," says Dange.

Experts claim this is a typical development syndrome most urban cities across the world are facing. "Cities are growing at such a rapid pace that basic infrastructure has failed to keep pace with it. Hence in Mumbai, more and more multi-storey buildings are coming up, whereas the municipality is not able to provide these basic services. More and more of drinking water is being sourced for Mumbai from many kilometres away, and more water supply means more wastewater. Also, many localities that do not have adequate municipal water supply depend on water tankers, so their wastewater does not count as official sewage. Again, to cut costs, many housing colonies prefer throwing their sewage into a nearby *nullah* rather than pay for an official connection," says Kapil Gupta, professor at civil engineering department of Indian Institute of Technology Bombay, Mumbai.

Where does the sewage from 40 per cent of Mumbai go? "Where else other than *nullah*s, rivulets and rivers such as Mithi, all of which empty into the sea. And it is wrong to only attack slums for polluting waterbodies. How much wastewater can a slum household generate, that hardly receives any drinking water supply? It is these housing societies/commercial complexes that are playing havoc with Mithi and government has turned a blind eye towards them," says Girish Raut, a Mumbai-based activist.

It stinks

"In Greater Bombay, dumping sites … are located along creeks… waste is deposited below high tide level without any soil cover. The creek water gets polluted on account of direct contact with refuse and on account of leachate. The refuse…does not get decomposed even after 3 years."

— Draft Regional Plan for Bombay Metropolitan Region (DRPBMR) 1996-2011, October 1995

Mumbai generates between 7,000 and 7,800 tonnes per day (tpd) of waste. And, as a recent paper *Waste management scenario in Mumbai: things can improve*, by Rakesh Kumar, director of the Mumbai office of National Environmental Engineering Research Institute (NEERI) puts it: "Mumbai's waste management problems are unique… It has least available space, hence landfilling is not sustainable… Residential colonies are in close proximity to dumping grounds... And due to high commercial activity, volume of waste generated is also high. A daily floating population of 65 lakh adds to the existing woes, whereas perpetual construction adds to the debris, which amounts to 2,500 to 3,000 tpd of total waste."

MCGM spends over Rs 575 crore per year on solid waste management. It has 29,500 employees. But only nine per cent of Mumbai has a door-to-door waste collection system; the rest use community bins. Waste is collected from designated points, loaded on trucks and thrown in three dumping grounds: Gorai in the western suburb (15 ha), and Deonar and Mulund in the eastern suburb (110 ha and 25 ha). Deonar receives about 4,300 tpd, Mulund about 1,500 tpd and Gorai about 2,000 tpd of waste. Contract vehicles carrying waste are paid on the basis of weight, so they prefer to

carry debris (heavier) and not garbage. And it is this inert debris, eating up almost 35 to 40 per cent space in landfill, that urgently needs to be diverted and reused, concludes a six-month NEERI assessment carried out early this year (see table: *Composition of Mumbai's waste*).

Plastics, too, are a big menace. In its 2005 report, NEERI recommended eliminating plastic bags: their "presence in waste has created problems at all levels — waste collection system, cattle grazing, storm and sewerage system blockages and limiting the capacities of landfill (it occupies 8-9 times the volume per unit its weight in landfill)". In the July 26 deluge, plastic bags choked drains, *nullah*s and sewer lines. Chief minister Vilasrao Deshmukh recently announced a ban on plastics across Maharashtra (see box: *Ban the bag*).

PILing litigations

The greatest threat is from unscientific landfills, neither lined, nor with a leachate collection system. According to Amita Athawale of the environmental pollution research centre of KEM hospital, poor ambient air quality near the Gorai dumping ground has lead to allergic rhinitis (caused due to high levels of suspended particulate matter, nitrogen oxide and hydrogen sulphide in the air) among residents. Residents face a serious threat of developing lung disorders.

People here have formed the Gorai Dumping Ground Hatao Kriti Samiti and filed a public interest litigation (PIL) in the Bombay High Court (HC). On July 20, HC directed the state government to hand over 141.77 ha of saltpan land in Kanjurmarg to MCGM for a new dumping site. But government claims this land is already earmarked for rehabilitating slums.

Mulund dumping ground is also wrapped in litigation. In 2004, the Hariom Nagar Residents Association filed a PIL in the HC demanding the landfill be properly managed. MPCB visited the site on September 2004 and observed the waste was "as high as 8-10 metres above ground level…waste had reached and partly entered the creek. If dumping continues, the creek may be filled with solid waste… no arrangements exist for collection of leachates… no arrangements for venting out methane gas…". But MCGM has given permission for residential buildings to be built near the dump site. MPCB found that MCGM has been continuously showing non-compliance towards the Solid Waste (Management and Handling) Rules, 2000. So it issued a show cause notice, to which MCGM HAS replied: "despite sincere efforts, it was not possible for MCGM to set up any processing plant and is beyond their control". People are also opposing MCGM's plan to take over a 45 ha plot in Mulund and develop a landfill. MCGM claims an alternate site, at Bhiwandi, would prove expensive due to huge transportation cost.

Yet another PIL has been filed by Shanti Park Co-op Housing Society, Ghatkopar, alleging acute air pollution due to Deonar dumping ground. "On the one hand, ragpickers purposely set fire to extract heavy metals from the waste; on the other, the waste itself generates methane leading to automatic fires and consequent air pollution," says an MPCB official. The DRPBMR admits extreme air pollution at Deonar: "Every day 6.3 tonnes of pollutants namely SPM, SO_2, NO_x and CO are emitted in air from these [dump] sites."

The greatest threat is from unscientific landfills, neither lined, nor with a leachate collection system

Last year the state government notified a chunk of land along the Eastern Express Highway, near Airoli in Navi Mumbai, to be developed as a landfill, but local people are up in arms. "Why should Mumbai's garbage be thrown in Navi Mumbai?," said an angry Vijay Chougula, Airoli's corporator. Strangely, DRPBMR does not oppose garbage disposal in wetlands: "no land, except low-lying area along creek, are available for disposal of solid waste… . It is important to recognise that though these projects affect wetlands, substantial environmental benefits will accrue and permitting them will result in possible trade-off".

According to Kumar, segregation and waste recycling at source or in the neighbourhood, an efficient doorstep collection of waste, waste processing for resource recovery and disposal of processing rejects in scientifically upgraded landfills are solutions that urgently need to be taken up. Mumbai will have to decentralise waste management: segregated biodegradable waste should be composted or biomethanated at the ward level only. The idea is that the bare minimum should reach the landfills.

But the question is: does Mumbai have the political will to do this?

Ban the bag

Is the government serious or is it another gimmick?

On August 23, 2005 the state cabinet decided to ban plastics bags throughout Maharashtra. Announcing the ban, the chief minister (CM) said there would be no thickness specifications for plastic bags; all kinds of bags would have to go. But there is no ban on making plastics bags; the CM believes this can be sold to other states. About five years ago, the state government had banned plastic bags less than 20 microns thickness, but failed miserably in implementing this ban. This time a time limit of 30 days has been set within which representations and suggestions can be made. A notification will then be issued.

The industry, from which the state annually earns Rs 3,000 crore, is angry. Harpal Singh, president of All India Plastic Manufacturers Association told media "this blanket ban is unwarranted. We will oppose this in the 30-day period… if the government remains adamant we will challenge it in the court." Maharashtra has about 30,000 units employing over 6 lakh workers who manufacture these ubiquitous bags. Annual sale of plastic bags fetches about Rs 800 crore. Mumbai itself has illegal units spread across Bhandup, Mulund, Vasai, Vashi and Navi Mumbai that manufacture bags below 20 micron thickness. But mpcb has raided only three units in the last five years.

Questions are already being asked about alternatives to milk packets, oil packets and IV fluid. Experts also doubt the seriousness of the state government, keeping in mind past failure to implement the ban. For now, it is wait and watch.

Mumbai panics

Again. Is there a way out?

September 9, 2005. Panic gripped Mumbai, again. Within 24 hours the city received more than 200 mm rain. It started pouring heavily in the morning. By 11 am the unrelenting downpour caused traffic jams. Not leaving anything to chance, the state government issued a rain alert. With Terrible Tuesday (July 26) fresh in mind, people left offices. Schools were shut down. As everyone came on to the roads, or headed towards local train stations, the Bandra-Mahim highway, a major intersection joining suburbs with the island city, was chock-a-block with traffic. Within an hour or so of rain, low-lying areas like Kurla, Sion, Mahim, Dadar, Andheri, Goregaon and Bandra East were flooded. To avoid another public backlash, the state government evacuated close to 300 families. The infamous Air India colony of Kalina once again went under water. Services on Central Railway were suspended for about 3 hours.

It is September 10 today, and the rain has still not relented. Most low-lying areas remain flooded and trains are running late. It is a holiday today and tomorrow, and people themselves are taking precautions not to venture out unless it's unavoidable. They know banking upon the government can be suicidal. Once bitten, twice shy!

Way out

"First and foremost we need to protect Mumbai's natural drainage system and implement the CRZ regulations that restrict construction activities. FSI restrictions within CRZ II zone should be strictly adhered to, and the 1991 CRZ rules implemented in their totality including the clause for a buffer zone. Projects such as BKC should not be cleared. Also there should be a check on permitting buildings that are constructed by blasting hiils," says Samant. "Rivers must not be channelised or forced to change course at the whim of a project," he adds.

Raut agrees. He wants the remaining mangroves to be granted the status of protected forests: "Mangroves are more efficient in cleaning up Mumbai's sewage than the present expensive sewage treatment plants."

What most experts agree with is that Mumbai needs to arrest its population growth. Sharma of TISS points out why:

- MMR's population will rise to 22.4 million by 2011.
- Gross water demand for the region in 2011 will be 7,959 million litres daily (mld) as against the present supply of 3,922 mld.
- By 2011, private vehicles will be more than double their 1991 levels.
- Peak period passenger trips will increase from 21.55 lakh in 1991 to 32.6 lakh in 2011, with public transport accounting for 85 per cent of the trips.

Kapil Gupta of IIT Bombay agrees and says, "Bringing in more water will mean more wastewater problems." "MCGM is unable to handle the present amount of wastewater, with 40 per cent of Mumbai still not sewered. How logical is it to generate more sewage?" he questions.

Various authorities/committees and fact-finding teams have been set up to revive Mithi river, but the recommendations of none are binding upon the government. So will they be of any help?

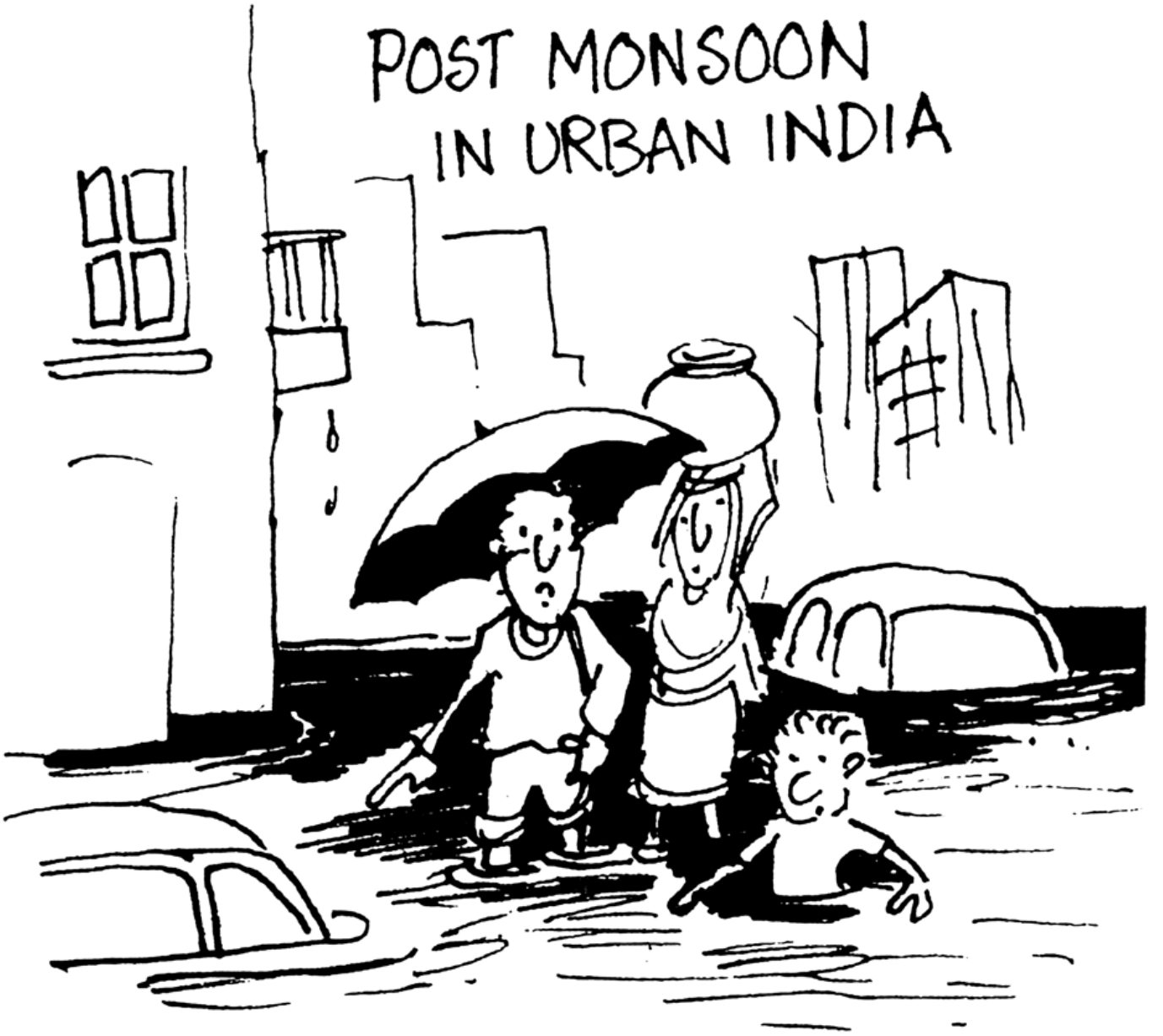
There are also discussions on getting rid of the present cement mania. Almost the entire city is cemented and no way can the water seep into the ground. Parts of Mumbai are already facing a saline ingress. Hence, it is important that water percolates into the ground and recharges the groundwater. For this porous building blocks could be used. Gupta claims that such blocks are used in most industrialised countries.

Protect open spaces

Mumbai needs to desperately protect its fast-dwindling open spaces. "Not only do these open spaces act as city lungs, but they are also holding ponds during heavy rainfall. Saltpan lands, which the state government wishes to open for construction activities serve exactly the same purpose and should be retained," says Samant. He accepts that reclamation is required, but says it should be done with care. "Reclamation can be done by either joining the low-lying islands or from the sea. Sea reclamation, though easy, is more expensive. First and foremost, wave patterns need to be studied and reclamation should be done in such a manner that the wave attack is not straight. Enough barriers should be put at the shore to absorb wave shocks."

Land-use maps need to be prepared with local people's participation. "Most people do not even know the land-use plan of their area. Hence, politicians and builders get these plots reserved or dereserved keeping in mind the market conditions," says Krishnan. Other angry Mumbaikars suggest non-payment of taxes (worth Rs 58,000 crore a year) to the Centre; some even demand a separate state. They claim that Mumbai's residents should have the right to elect their chief minister, so that there is some accountability.

But, there are hardly any public protests. It is this *chalta hai* attitude Mumbai needs to jettison. Hopefully, July 26 — and now, September 9 — will wake peopleup. For future's sake. ■



" That slimy ooze is sewage, those bubbles over there are hazardous wastes, that dark flow is industrial effluents and we are still looking for water."

THE POLITICAL ECONOMY OF DEFECATION

This is a story about Delhi and the Yamuna, about the relationship between one of India's richest cities and one of her most revered rivers. The plot is an economical one: the Yamuna stretches 22 kilometres along Delhi, but after Rs 55 crore to Rs 75 crore spent per kilometre on cleaning it up, the river is more spent than ever today. Devotedly, the city continues to faecally transform a river into a vast stream of flowing slime.

The story dwells on the existing clean-up strategy along the river. Briefly. For two reasons, argue SUNITA NARAIN and S V SURESH BABU. First, the Delhi stretch compels attention. Second, there is no point in sentimentally echoing what agencies responsible for the river's clean-up say: here is an endless tragedy.

It suits these agencies — especially in Delhi — to keep crying over expensively spilt sewage. But it is more important to put in place a strategy that works.

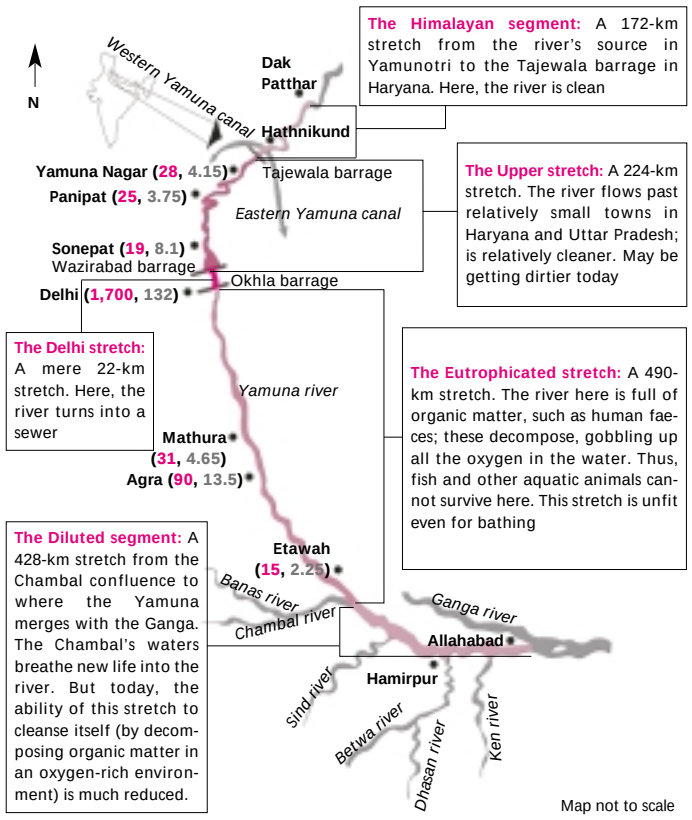
In the Delhi stretch, that's possible. In the future, the Yamuna can flow again

Knocked out loaded

The Yamuna's pollution load

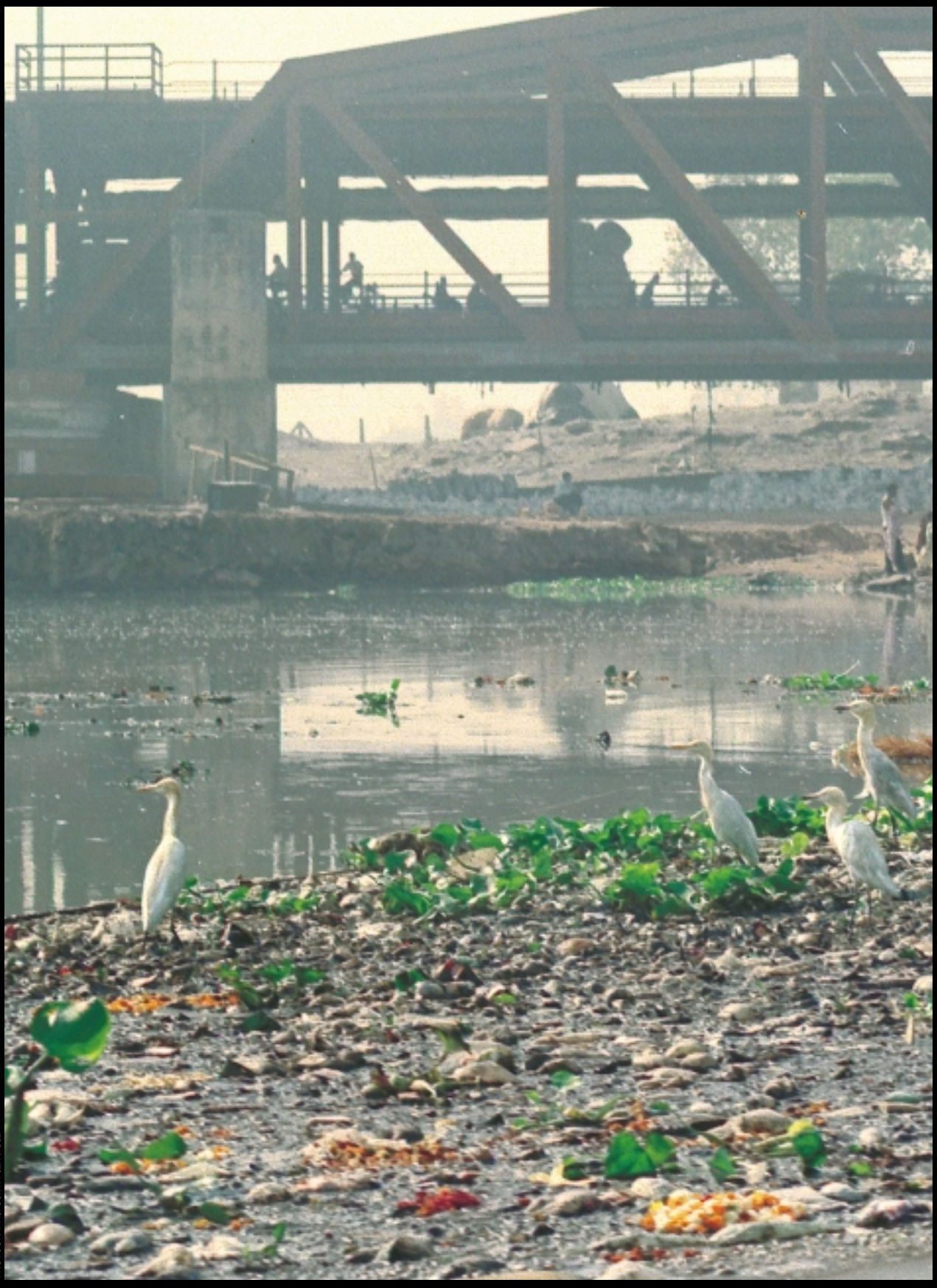
The Central Pollution Control Board (CPCB), the nodal agency that monitors water quality in rivers in India, divides the Yamuna into 5 segments.

CPCB's latest data on the pollution load in the river harks back to the earlier millennium, to 1996. The data is outdated. Still, it clearly shows any analysis of the river's condition must begin from Delhi (though not end there).



Note: All figures are 1996 levels. **a** = Flow, in million litres per day: the amount of wastewater, domestic and industrial, that falls into the river; **b** = BOD load, in tonnes per day: volume of flow X concentration of BOD, or biochemical oxygen demand — a parameter to measure the amount of oxygen required to break down organic matter floating in it.

Source: Central Pollution Control Board 1996, Report on Water Quality Monitoring of Yamuna, CPCB, New Delhi, mimeo.



PHOTOGRAPHS: SURYA SEN / CSE

Yet-to Action Plan

A decade-old drive to clean up the Yamuna, in Delhi and elsewhere

In April 1993, the Union government launched YAP, the Yamuna Action Plan, to tackle the river's pollution. Since then, schemes have been implemented in 21 towns along the river in three states (Uttar Pradesh, Haryana and Delhi). YAP itself has changed. Its first phase, called YAP-I, was scheduled for completion during April 2002. But an extended phase of YAP-I ran from May 2001 to February 2003. Currently, it is passing through its second phase (YAP-II, 2004-2008).

Since YAP's inception, a lot of money has been spent. Fuelled by Japanese bilateral funding, Rs 732 crore was sanctioned in the three states in YAP-I plus the extended phase. Another Rs 573 crore has been allocated for YAP-II. Till March 2004, YAP's total expenditure stood at Rs 674 crore.

Perfect plans

The plan of action has largely consisted of:

- Building sewage treatment plants to treat domestic sewage
- Building common effluent treatment plants to treat industrial waste
- Repairing city sewage systems — drains, pumps and pipes
- Building sewage systems and low-cost toilets to connect the waste of slums and poor settlements to treatment plants
- Building electric crematoria.

On paper, this plan works.

Imperfect reality

Unfortunately, the plans do not work except on paper. The allocations to states have been varying throughout the programme, and these variations point to consistent lack of focus. For instance, the bulk of the money spent so far has gone to Haryana and Uttar Pradesh. Whereas the Delhi stretch has been the most polluting one — by 1996, the CPCB had estimated Delhi contributed 70 per cent of the pollution load of the entire river — it got only 2.7 per cent of the treatment capacity created under YAP (see graph: *Regional imbalance 1*). Further, YAP has simply not taken into account the relation between pollution load generated, state-wise, and sewage treatment capacity created. Out of the 743 million litres daily (mld) of such capacity created, 401.25 mld capacity, or 54 per cent, was in Uttar Pradesh, which in 1996 generated only 20 per cent of the polluting load. Haryana generated only nine per cent of the load, but 43.3 per cent of sewage treatment capacity was created there (see graph: *Regional imbalance 2*).

Imbalances continue to plague YAP. Under YAP's extended phase, Rs 150 crore or 90 per cent of the allocation was channelled into Delhi, to set up 1,146 toilet complexes in 1,100 slum clusters and 46 resettlement colonies and so tackle the problem of sewage disposal. An analysis by the National River Conservation Directorate shows 60 per cent of these complexes remain unused: they have no water, or are too expensive for people to use, or simply improperly sited or ill maintained.

Delhi's clean up

YAP is not the end of the story. Delhi has spent much more on river cleaning, largely on the directions of the Supreme Court (see box: *SC wields the broom*). It can be estimated that since the mid-1990s the government of Delhi has invested about Rs 900 crore to 1,200 crore on building sewage and waste treatment facilities. In all, the total expenditure would amount to Rs 1,100 crore to Rs 1,450 crore till date. Once the YAP-II money is spent, as the government

Costly plans

Capital investments in Delhi (Rs crore)

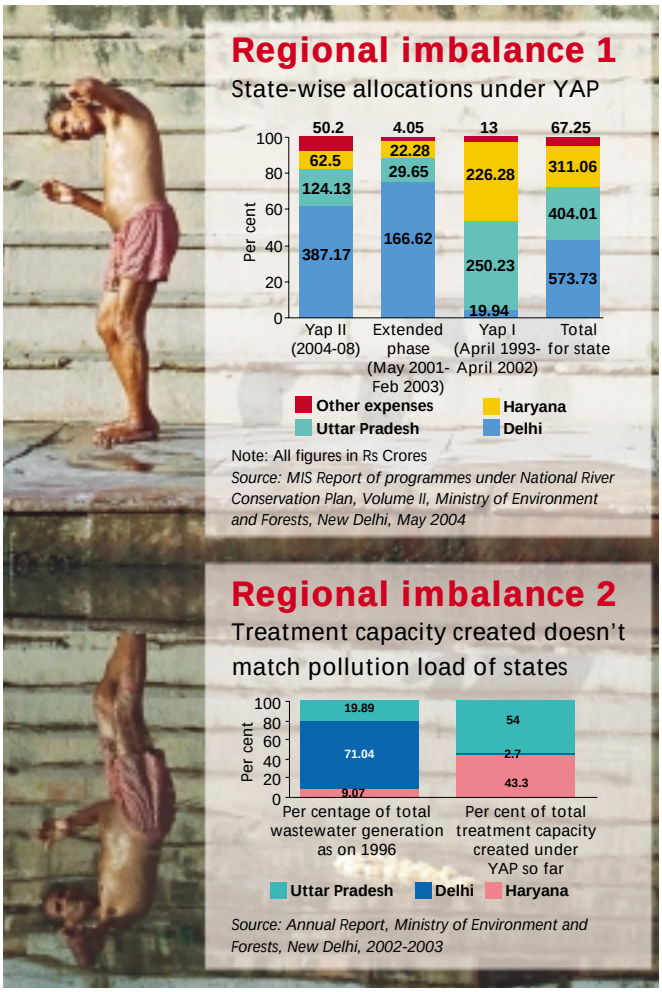
YAP-I	19.94
YAP extended	166.00
17 sewage treatment plants	745.60-1000.00*
15 Common Effluent Treatment Plants	256.00
Total	1187.54-1443.84

*Estimated.
Source: National River Conservation Directorate, 2004; Environmental Pollution Control and Prevention Authority

hopes to soon, it would have invested Rs 1,400 crore to Rs 1,900 crore just to clean up a tiny 22-km segment (see table: *Costly plans*)

And sadly, the urgency of cleaning the river up has got lost in an endless process of government agencies 'administering' to court directives. The result is money down the drain:

- In the 1985 M C Mehta versus Union of India and Others case, the apex court ordered, in 1996, that 15 common effluent treatment plants (CETPs) be constructed to treat 190 mld of industrial wastewater. By 2004, only 10 CETPs had been constructed; two were being built and the other three are yet to be commissioned. The cost of construction has escalated from the initial Rs 90 crore to Rs 256 crore, and only 53 mld of industrial wastewater reaches the finished plants
- In the "mailee" (dirty) Yamuna case, the Court ordered, on April 10, 2001, that it was "imperative that at least by March 31, 2003, the minimum desired water quality of the river is achieved…". To this end, a dissolved oxygen (DO) level of 4 milligrammes per litre had to be maintained (DO shows how 'alive' a waterbody is). Two years later, the river is dead.
- In the case residents of NOIDA filed, the Court made a comprehensive order, in November 1998, including creation of facilities to treat 495 mld of sewage. But by January 2005, only 295 mld treatment capacity had been built, or a little over half demanded. Pumping stations came up and sewer lines laid, but the system wasn't connected to households! Only 63 per cent of sewage facilities created are utilised.



THE STP RUSH

Chasing treatment plants, not sewage

The government's favourite strategy is to construct sewage treatment plants (STPs). The rush began in 1995. First, there was a plan to build and make operational 14 STPs by 1997. In 1998, another two were contemplated. By 2000, 8 were under different stages of construction. By October 2000, Delhi's chief secretary reported to the court that 9 STPs were functioning against the 16 to be constructed. Sewage treatment had also increased, from 990 mld to 1,400 mld by June 30, 2000, he said, assuring the court that by March 2001, with five more STPs functional, the city would treat 1800 mld waste.

This, he deposed, would help solve the problem, as the percentage of untreated sewage discharged into the river would decline from 63 per cent in 2000 to 34 per cent by 2001,


S V SURESHABABU / CSE

The Okhla STP: Delhi's biggest, but not its best

20 per cent in March 2003 and 5 per cent by March 2005. The plants certainly got built. Today, Delhi's 17 STPs have a treatment capacity of 2,330 mld. The problem is that nobody quite knows how much sewage the city generates (see: *Why is the Yamuna so polluted*?). If the sewage generation estimate of the Central Pollution Control Board (CPCB) is used — 3,853 mld — then the city can treat 60 per cent of its waste. If the estimate of the Delhi Jal Board (DJB), 2,934 mld, is accepted, then 80 per cent of the wastewater generated can be treated.

The STP strategy remains the hot favourite. In late 2004, the Anil Baijal committee (Baijal is secretary, Union ministry of urban development and chaired the committee) set up by the Supreme Court to prepare an action plan for Yamuna, recommended to the court the DJB would invest further in infrastructure for sewage treatment — increasing from the present capacity to 2,880 mld in 2008 to 3,758 mld in 2015. This, the committee believed, would keep the sewage chase on track.

Repairing non-ending drains

The problem also is that a large portion of the city's existing sewer lines — about 5,600 km long, which include 130 km of trunk sewers — are either silted or settled. Government says that only 15 per cent of the trunk sewers are in order. So, for the past many years of river cleaning, the government has set

Removing thermocol debris in the Shahdara drain

DEBOJYOTI KUNDU / CSE

SC wields the broom

But government sweeps over

The first case asking the Supreme Court to intervene in making the Yamuna in Delhi a cleaner river was filed by environmental activist M C Mehta in 1985. Subsequently:
1992: Sureshwar D Sinha, chairperson of a Delhi-based non-governmental organisation called Paani Morcha, filed a writ petition pleading for enforcement of measures to stop the high rate of pollution from Delhi. Arguing the Union government had no right to approve plans that rendered the Yamuna dry for 9 months in a year, the petition also demanded the Court permit fair levels of water flow in the Yamuna.

The 'minimum flow' case, as it came to be called, is still on. The plea for minimum flow has been heard, by a high powered committee and even by the governments of the states that share the river's water. Though a consensus was arrived at, minimum flow of 10 cubic metre per second, essential for the river's health, is yet to be ensured for this stretch.
1994: Supreme Court judges *suo moto* (on their own) took cognisance of an article published in daily newspaper *The Hindustan Times*, called *And Quiet Flows Mailee (dirty) Yamuna*, and filed a case against the Central Pollution Control Board and others for failing to discharge their duties in cleaning up the river.

The case goes on. In its duration so far, important orders were passed. But the river still flows *mailee*.
1996: Residents of sectors 14, 14A, 15 and 15A NOIDA (in the trans-Yamuna area), reeling under the effects of the Shahdara drain, filed a writ petition pleading relief.

The case is still on. Progress on the orders the court made is simply appalling. The implementing agencies are still pleading to extend deadlines, which were missed almost 5 years ago.

deadlines to clean the trunk sewers to Delhi, to transport the sewage to STPs. A simple plan, it would seem.

In October 2000, the chief secretary informed the court that an action plan has been launched for the rehabilitation of 22 trunk sewers at a cost of Rs 155 crore. "Work has already commenced and all 22 items of work are scheduled to be completed by December 2003", said the government. But the drains have never been repaired. Only the money has been spent. By 2004, the government has accepted that only 30 km of 'rehabilitation' work had been completed. Now government wants the court to extend the deadline for trunk sewer repair to 2008.

Chasing targets and targeting poor people

The plan is also to provide sewerage in authorised colonies not connected to the official sewerage system.

But the fact also is that over 40-50 per cent of Delhi's people live "illegally", in unauthorised colonies and slums. Unconnected to the sewerage system. In 2001, government said it would complete sewerage of 490 regularised but unauthorised colonies by March 31, 2003 and the rest by March 31, 2004. However, by 2004, it had only managed to complete the internal sewerage of 482 of these colonies; now it would aim to lay sewerage systems in the remaining 496 such settlements by December 2005. The problem is even larger, when one understands that vast numbers of people live in colonies, which are classified as unregularised and unauthorised, where the government has no plans to even introduce sewage systems.

The action plan also aims to remove poor people living along the river, so that the river can be cleaned. In 2001, the state chief secretary told the Court that out of the 600,000 slumdwellers in the city, roughly 60,000 lived along the river. These poor people contributed to the pollution, the government believed. So, over the past 10 years, every successive government has, in the name of river cleaning, worked hard to remove slums of poor people. Nobody has ever asked what is the evidence that these poor people living on the banks of the polluted river, are its villain and not its victims.

CRORES SPENT, WHAT'S BEEN THE IMPACT?

3 PARAMETERS

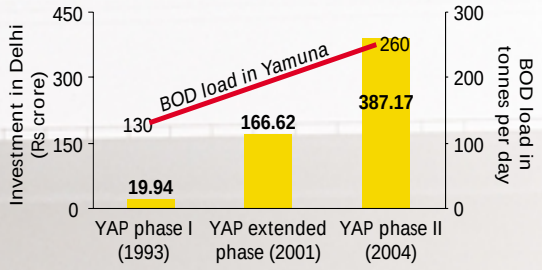
Three telling parameters exist to measure river purity:

BOD, or BIOCHEMICAL OXYGEN DEMAND: It represents the amount of oxygen a river requires to break down organic matter floating in it. High BOD levels indicate extent of organic pollution, such as faeces, in the wastewater that flows into a river; they also indicate a river is polluted by organic matter and is increasingly unable to decompose the matter

DO, or DISSOLVED OXYGEN: The less oxygen there is in a river's water, the less it can decompose organic matter, losing the ability to clean itself up

TOTAL COLIFORM: Coliform bacteria can live both with and without oxygen in a river. Total coliform includes *E Coli* and FAECAL COLIFORM. The latter's presence in a river's water indicates the water has been contaminated by human, or animal, faeces. Total, or faecal, coliform are calculated in terms of mpn, or most probable number per 100 millilitre (ml) river water.

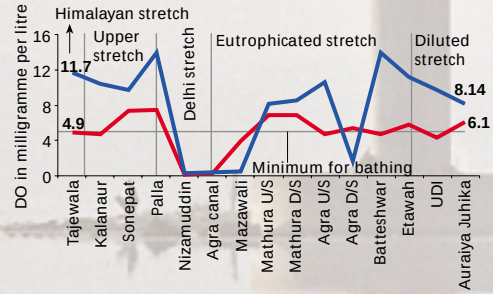
THE MORE DELHI INVESTS THE DIRTIER YAMUNA GETS



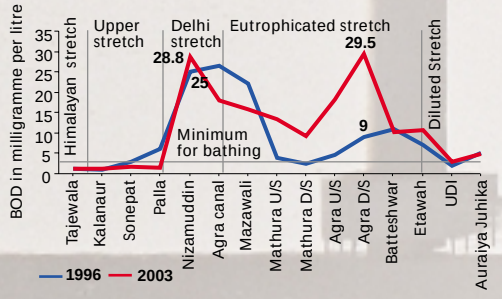
Source: 1. National River Conservation Directorate, 2004; 2. Central Pollution Control Board

ALL THE STRETCHES OF THE YAMUNA ARE DIRTIER TODAY

1996-2003: Levels of Dissolved Oxygen (DO) have drastically reduced, even in the cleaner stretches

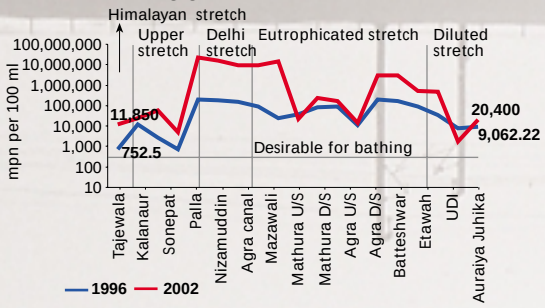


1996-2003: Levels of Biochemical Oxygen Demand (BOD) have increased, indicating organic pollution



Source: MIS Report of programmes under National River Conservation Plan, Volume II, Ministry of Environment and Forests, New Delhi, May 2004

1996-2002: Levels of faecal coliform increased all round, indicating greater bacterial contamination

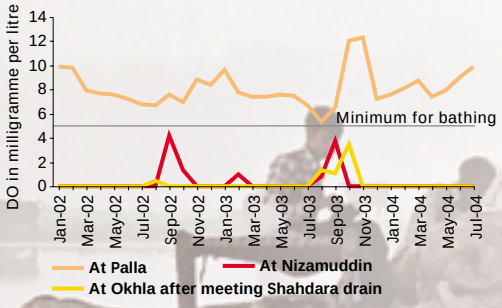


Note: U/S = upstream; D/S = downstream

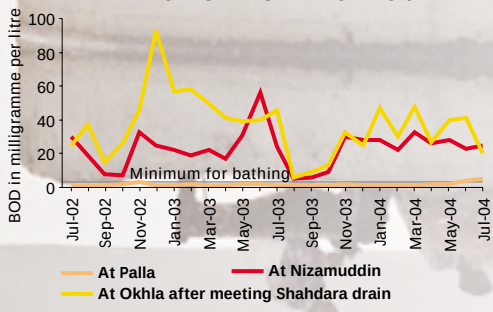
Source: http://yap.nic.in *as viewed on September 10, 2004*

THE DELHI STRETCH STINKS TO HIGHER HEAVEN

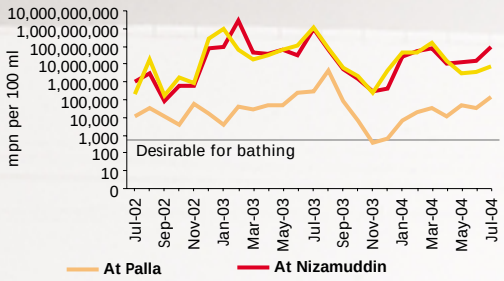
2002-2004: Hardly any Dissolved Oxygen (DO) in the river in this stretch: it is really dead here



2002-2004: Biochemical Oxygen Demand (BOD) levels remain very high: organically very polluted



2002-2004: Total coliform levels increase, indicating severe bacterial contamination



Source: Compiled from water quality monitoring reports of CPCB, 2002-2004

Why is the Yamuna so polluted?

MRIDUL / CSE

In Delhi, nobody knows!

Could it be that Delhi's clean-up infrastructure is an effect of mindlessness? Consider: while it is broadly accepted that domestic sewage contributes between 80-90 per cent of the pollution load, and industrial effluents the rest, nobody has any clue on how much waste is industrial and how much domestic. So what is all the infrastructure for?

In the *Mailee Yamuna* case, Supreme Court judges were annoyed enough to note in their August 2004 order that "There is nothing authentic on the record as to what is the total generation of different kinds of pollutants. The capacity of the 15 sewage treatment plants in Delhi is also not known, though it was stated in the affidavit of the chief secretary that in November 2001, the capacity was 1,990.80 million litres daily (mld), to be increased by March 2005 to 3,318.30 mld."

The judges also note: "The chief engineer of Delhi Jal Board (DJB) present in court states that the total capacity as of now is 2,305.8 mld. According to him, the total generation is 2,934 mld. We do not know the correctness of these figures. Assuming the same to be correct, the generation of waste is more than the total capacity of the STPs. Despite these facts and figures — whether correct of not, whether the STPs are working to full capacity or not — one thing that is clear is that the quality of water in the last 5 years has…deteriorated."

Justified annoyance

There is no consensus on how much wastewater the city generates. CPCB estimates that in 2003-2004, 3,853 mld wastewater was discharged into the river, from the 22-odd drains that traverse the city. However, the Baijal committee in 2004 estimated generation to be 2,960 mld. Given the policy implications of waste, this difference of almost 1,000 mld is simply too massive to ignore.

The water-sewage arithmetic

The fact is that the quantum of waste a city generates is in direct proportion to the water it consumes: at a minimum, 80 per cent of water supplied to a household leaves as waste. In other words, the river's pollution is directly linked to mindless water planning and management in the city.

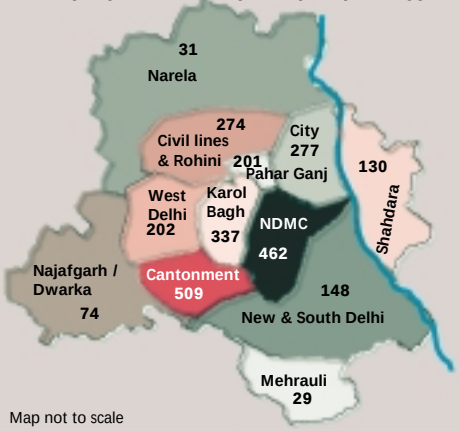
City planners really do not know how much water the city

All about inequity

The political economy of water in Delhi is about power and inequity:

- **Three per cent of the population receives more than 450 litres per capita daily (lpcd): areas under the New Delhi Municipal Council (NDMC) get 462 lpcd; Delhi Cantonment receives 509 lpcd. Thus, this three per cent receives 11 per cent of the water the Delhi Jal Board supplies**

Inequitable water supply in Delhi
(in lpcd, or litres per capita per day)



Source: Down To Earth, June 15, 2002, p 60

uses. At present, the city's water demand is about 3,600 mld, it has a capacity to treat 2,880 mld raw water and it officially supplies 3,040 mld of water. This includes 410 mld of officially drawn groundwater, which then adds to the waste stream.

But the water supplied does not reach people. The DJB admits that only 1,730 mld water reaches its consumers. It can be assumed then that people have to depend on groundwater aquifers — tubewells — for their supplies. But how much groundwater is extracted in Delhi is a mystery. Given the water-waste connection, the mystery deepens as the city hunts for how much sewage it generates.

The fact also is that nobody plans for sewage when they plan for water. For instance, the city government plans to supply another 630 mld of water as soon as Uttar Pradesh releases water from the Tehri dam to the city's Sonia Vihar water treatment plant. In other words, 3,510 mld water treatment capacity will now be available to the city, and each citizen will get 250 litres per capita daily (lpcd). The waste this water will create is still unaccounted for. (see box: *All about inequity*)

Water-waste connection

To understand what this profligacy means in waste terms, compare Delhi to other cities of India. According to a CPCB survey, at today's rate of water supply, Delhi contributes 23 per cent of the total wastewater generated by Class I cities (cities with more than 100,000 people). More shockingly, this is 47 per cent of the waste generated by 101 Class I cities and 122 Class II cities (Population: 50,000-99,999) in the Ganga basin. In other words, all these cities put together generate less than about 50 per cent of what Delhi excretes.

At 3,600 mld of water use, Delhi would generate 2,800 mld of waste, somewhere between the 2,900 mld estimated by DJB and CPCB's 3,853 mld estimate. The fact is that the CPCB estimate is based on the flow into the river, while the DJB estimate is based on the water it purportedly supplies. The gap — of 1,000 mld of waste — is possible based on the use of groundwater in the city as well as the waste it receives from its neighbours. The bottomline is that even as the government is planning full-steam to combat pollution in the river, its agencies do not know how much waste and want there is in the city.

Another mystery

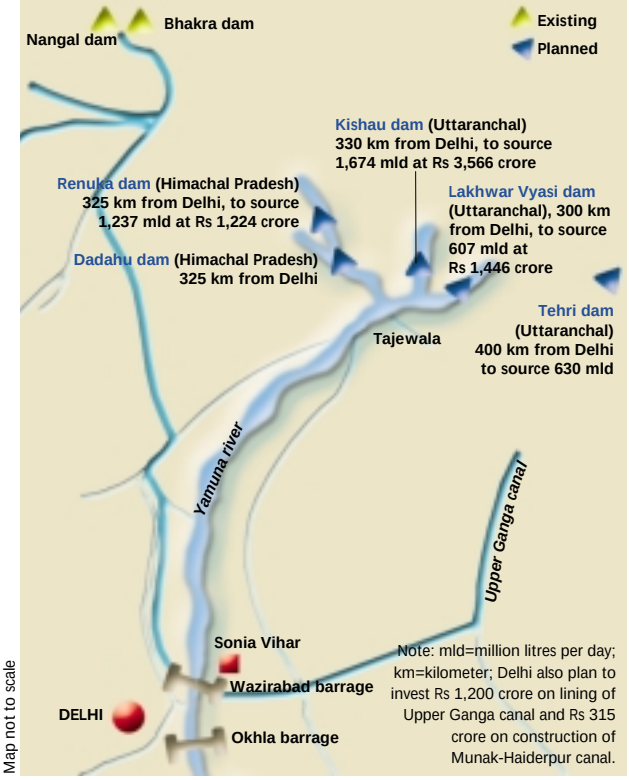
In the late 1970s, many years before the inception of YAP, the CPCB had estimated that there were 359 industrial units, which were discharging water effluents. In 2000, CPCB observed that there were 42 industrial units in Delhi directly polluting the Yamuna.

For industrial discharges, too, figures vary significantly with the estimating agency. For instance, in 1994 the Delhi Pollution Control Committee, in its affidavit to the Supreme Court, informed it that 320 mld of industrial waste was discharged into the river. The Baijal committee quoted a study by the National Environmental Engineering Research Institute that industrial wastewater generation in the city is around 180 mld.

By April 2005, the city has 10 common effluent treatment plants with a capacity of 133 mld, set up by the Delhi Small Industries Development Corporation. But only 53 mld of industrial waste reaches these plants.

Height of planning

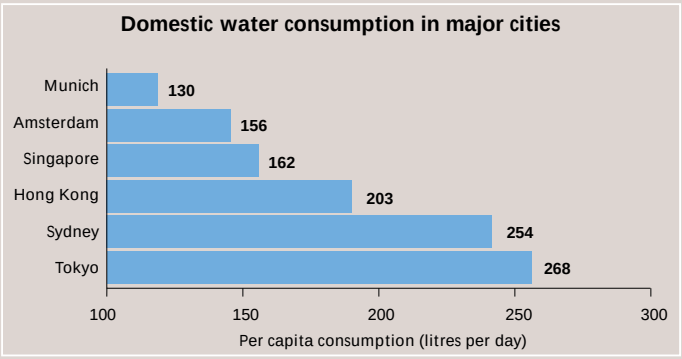
Delhi's planners are completely oblivious of the direct relation between the water a city consumes and the waste it generates: Delhi is planning to source more water at Rs 7,750 crore; what will the city do to the Yamuna in future?



● 70 per cent of the population living in villages in the National Capital Territory consume less than 5 per cent of the total water supplied.

In other words, if the Yamuna's destruction is linked to water usage, it is rich and powerful Delhi that is most responsible.

● To better understand Delhi's water profligacy, look at the richest cities of the world. Copenhagen in Denmark uses roughly 125 lpcd of water as on 2002 (reduced from 200 in 1991). Singapore has succeeding in maintaining consumption at 165 lpcd for the last five years. Many Organisation for Economic Cooperation and Development (OECD) countries are striving to achieve consumption levels below the OECD average of 180 lpcd.



Source: http://www.pub.gov.sg/downloads/pdf/soe_chap2.pdf as viewed on April 7, 2005

This investigation into Delhi's underbelly began with a visit to a sewage treatment plant located in the eastern part of the city, situated between a highly congested and relatively poorer part of the metropolis. The officials at the plant — known as Yamuna Vihar, which can treat 90 mld of waste — were proud of their achievements. They told us they cleaned up the waste effluent substantially. They showed us treated effluents stored in glasses, almost pure, as proof. They told us they spent money — electricity, labour and chemicals — to treat the effluents. Here was a success of river cleaning.

But wait. We asked then where the treated effluent was discharged. Silence. We persisted. They took us to the spot. It was outside the sewage treatment plant, there was a dirty drain, full of untreated sewage. They dumped their nearly pure effluent in it. It made no difference.

Why, we asked, was this done? The answer was pat. Nobody had planned for the disposal of the treated effluent. They had built this plant, because there was land available here. The drain outside their sewage treatment plant was polluted because it contained "illegal" sewage. It did not belong to the government as it came from unauthorised and illegal colonies, unconnected to the official sewage system.

But there was more. We travelled down this drain. It is called drain no. 1 and meets Ghazipur drain, some 14 km down. Here the government has built another sewage treatment plant, called Kondli. This has the capacity to treat 205 mld of sewage. The treated sewage of Yamuna Vihar would be recycled for treatment again, at this plant, before it could be released into the river.

But wait. We moved further down. Now the Ghazipur drain joins the Shahadra outfall drain. The plan was to intercept the sewage and to pump it back to Kondli, where it would be treated and then disposed off. Sounds logical. But then we looked at where the sewage would be disposed of and the logic blew away. The treated effluent and retreated effluent and pumped and treated effluent, would all be cleaned and then disposed off in another drain, which was equally polluted and traversed another 5.5 km through more polluted environs, before it reached the river.

The facts emerged. The area needed wastewater treatment capacity of roughly 500 mld. By 2004, only half of this capacity was built. But also by 2004, only 63 per cent of whatever capacity was created was utilised. In other words, a little over half of the treatment facility had been set up and a little over half of the set-up was being used. In addition, the wastewater that was treated was discharged right back into the wastewater drain, to be then — amazingly! — picked up for re-treatment. This in a region, where 40 per cent of the people live without sewage facilities. Pollution is about sewage. We know. So we learnt about pollution control. More than we are able to tell.

What to do?

The planning mess must change

Seventeen sewage treatment plants, 10 common effluent treatment plants, drains, pipes, low cost toilets, and thousands displaced in the name of river cleaning. But little impact. Why? That is what needs to be understood so that future policy can be built learning from past failures. Otherwise, there will be more money and pollution down the drain.

The simplest answer to this riddle is that sewage treatment capacity has not kept in step with population and waste

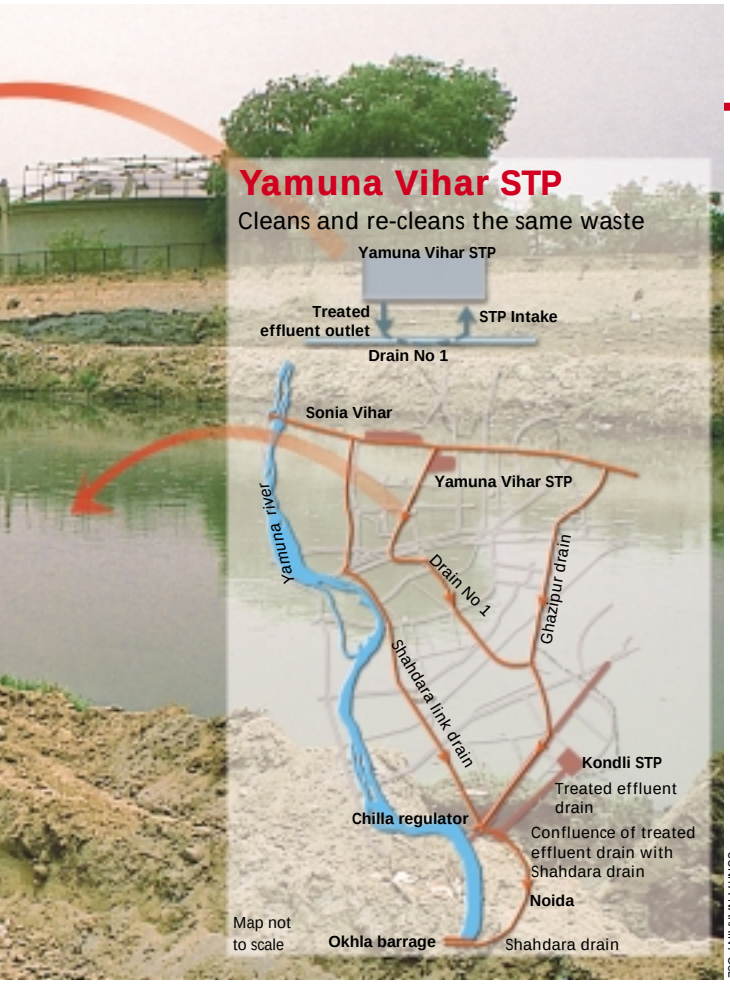
Look to Delhi's six big drains

City's clean-up plans overlooks them

- **22 drains criss-cross Delhi. Of these, six drains — the Najafgarh drain, the Shahdara drain, the drain near Sarita Vihar bridge, the Maharani Bagh drain, the Barapulla drain and the Sen Nursing home drain — contribute 90 per cent of wastewater flow into the river and 81 per cent of the river's BOD load during 2003-2004**
- **According to CPCB data, Najafgarh drain's contribution towards wastewater flow into the river has reduced, from 67 per cent in 1995-1996 to 48 per cent in 2003-2004. In the same period, the average annual BOD concentration has remained around 40 milligramme/litre (mg/l), almost double the standard set for treated effluents from STPs.**

Yet this drain remains the worst in Delhi. The BOD load the river receives from this drain is a whopping 72 tonnes per day

- **The Shahdara drain's contribution to wastewater flow has also reduced, from 22 per cent in 1995-1996 to 16 per cent in 2003-2004. But its BOD load has increased from 36 tonnes per day to 51 tonnes per day: the drain is today more polluted**
- **A vital indicator of pollution is BOD concentration. In these terms, two 'middle class' drains — the Maharani Bagh drain and the Sarita Vihar drain — are the worst, with BOD concentrations respectively of 300 mg/l and 250 mg/l**
- **The levels of TSS, or Total Suspended Solids, have increased in all six drains. The Maharani Bagh drain and the Sen Nursing home drain have concentrations as high as 400 mg/l. This is dangerous, for higher TSS levels mean more sediment deposits in the river.**



SUNITA NARAIN / CSE

(above) Drain no 1 slinks past the Yamuna Vihar STP, which picks up its wastewater, only to flush treated effluent back. (right) Foamy, polluted, 'cleaned' effluent at the Okhla STP

growth. This sewage-infrastructure approach is a game of catch that misses the point. Fact is that, officially, Delhi has an installed capacity to treat between 60-80 per cent of the domestic waste it generates. But the river still receives huge volumes of untreated and dirty effluents. Why?

BUILT BUT NOT USED: The fact is that the existing infrastructure to treat sewage remains grossly under-utilised. CPCB itself has revealed in a 2004 report that 13 out of the 17 STPs are under-utilised; one of them does not receive any sewage.

The report indicates that about 73 per cent of Delhi's STPs are functioning below design capacity, whereas 7 per cent are lying defunct. And just as some plants do not get sewage at all, others get too much and so cannot function efficiently! (See graph: *Built but useless*).

TREATED AND NOT TREATED: The gap between treated and untreated sewage is underestimated. Only 1,470 mld of sewage is actually treated in the 17 STPs, less than 40 per cent of the wastewater that flows into the river. It is no wonder, therefore, that the river remains polluted.

WHERE THERE IS AN STP, THERE IS NO SEWAGE: Drains to channelise sewage to the treatment plants exist, but do not function. The problem is that the DJB has been trying to repair these sewers unsuccessfully over the past 10 years. Drain cleaning has become an exercise in perpetuity and futility.

WHERE THERE IS SEWAGE, THERE IS NO STP: The location of STPs is decided on the basis of land availability and not pollution management or even sewage management. So, Delhi's STPs are invariably built in areas where the sewage needs to be trans-

The sums of treatment

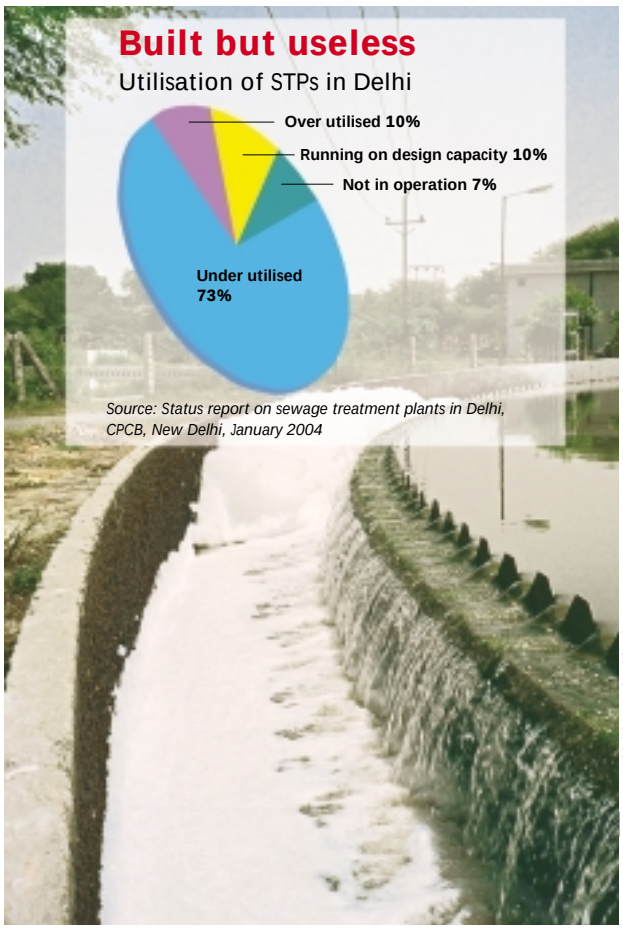
What is the quality of treatment in sewage plants?

Firstly, pollution regulators only work on the basis of three parameters — BOD, COD (chemical oxygen demand) and TSS (total suspended solids). These are clearly inadequate. The key issue is that the waste is full of pathogens deadly to our health. Only in some plants — those built using Yamuna Action Plan money, and so affiliated to National River Conservation Directorate (NRCD) — is the NRCD-set coliform standard (1000 mpn/100 ml) applied. But in these plants, the disinfection units, which use ultraviolet radiation to kill coliform, are invariably out of order.

Other plants, where CPCB standards apply, do not have a coliform standard, for no such design requirement is applicable to them. In other words, these expensive plants can be built, and still pollute. For instance, in the Okhla sewage plant, even as the BOD has been brought down to 20 mg/l the best coliform levels are as high as 2.4 crore mpn/100 ml. It is no wonder that the river is high in coliform when it leaves Delhi.

The problem also is that because of faeces and urine in the wastewater, the ammonia content is high. There is little information if STPs meet the ammonia standard, but even if they do, the problem is using chlorine as a disinfectant. Already high in ammonia, wastewater so treated will lead to its own set of toxic problems.

All STPs generate huge quantities of sludge. In the past, this was re-used in agriculture. No longer. Moreover, this is sludge of a modern city, full of toxins, untreated and unchecked. What will it do to our lands if used there?



S V SURESH BABU / CSE

Rich sewage

The political economy of defecation

The government says that poor people living along the Yamuna are the problem. But the fact is that s/he who uses the most water also generates the most waste. The situation in India's capital city is shameful in this regard. The bulk of the water goes to the rich and powerful, with the majority population getting less than survival quotas of water. Therefore, it is the water users who generate waste. If water use is the criterion for a pollution inventory, then it is clear that the rich, not the poor and unconnected or unserviced, are the cause of the river's condition.

What does treatment cost?

The issue, then, is: what is the cost of wastewater treatment? Who pays for pollution control? The water users in the city are connected to the sewer system, their waste is transported long distances to STPs and then treated, before disposal. More water means more money to clean up waste. There are really no estimations on this waste bill of the city.

What can be estimated is on the basis of the capital and running costs of STPs. On checking with agencies, it was found that an STP in Delhi costs between Rs 20 lakh to Rs 66 lakh per million litres of waste treated per day (mld). This cost varied with the technology used and the quality of treatment. But on an average, an STP costs roughly Rs 40 lakh per mld.

What, then, would be the average cost per person? This would depend on the amount of water a person uses and so the waste s/he discharges. If the person gets water supply at 60 litres per capita per day (lpcd), s/he will generate 48 litres of waste per day. In this case, a one mld plant will treat the waste of 20,000 people, at a capital cost of Rs 40 lakh per mld. In this case, the cost each person must pay would be Rs 200 for the capital cost of plant.

But the same equation changes, as water use changes. At the Delhi rate of water supply, 200 lpcd, the same plant will treat the waste of only 6,250 people. In this case, the capital cost per head will be Rs 640 and the city would need to build more STPs.

It also costs to operate and maintain these plants. The treatment costs range between Rs 0.40 to Rs 2.5 per kilolitres depending on the technology adopted and cost recovery possible from the STP.

So water saved is money saved, literally. If water users in Delhi do not pay for their water and waste, in this political economy of defecation, they are being subsidised to excrete in convenience. To the inconvenience of us all. And the river.

Was her house broken in the name of river-cleaning

ported long distances for treatment. In the case of its largest STP, the transportation of waste costs more than cleaning it up. But more importantly, Delhi has to depend on a sewerage network of 5,600 km to convey its wastewater to treatment facilities. The network needs a lot of repair, thereby turning sewage-sourcing into a costly and inefficient problem.

WHERE THERE IS SEWAGE, IT IS "ILLEGAL": But it is also the case that drains that can transport sewage do not exist at all, because there are settlements are not connected to the sewage system at all.

Almost 50 per cent of Delhi generates 'illegal' sewage — it is illegal because it is not transported through official sewers to official treatment plants. In the colonies categorised as regularised but unauthorised, agencies have been digging to provide sewage facilities, without much success, over the past many years.

But in the vast number of colonies categorised as unregularised and unauthorised, there is no such plan. The sewage from these areas, for there is bound to be sewage, will flow. Into the drains of government. But it is illegal because it is not official. So, nobody can, or is willing to, plan for it!

WHAT IS LEGAL THEN MIXES WITH THE ILLEGAL TO CREATE POLLUTION: A large proportion of waste remains untreated. Some is treated, at high cost. But if the latter is disposed by mixing it with untreated waste, then all the effort at pollution control is completely negated.

This is what happens in Delhi. Almost all STPs drain the treated effluents into nearby drains already full of untreated and illegal sewage. These drains, on their way to the river, then collect more waste and become more polluted.

By the time the drains meet the river, there is only polluted waste. No treated effluent.

The muck stops here

Indian lakes are no longer serene waterbodies. Instead, they have become stinking cesspools, a result of continuous inflow of sewage and massive siltation. As the lakes die a premature death, the question that arises is who is responsible for this sorry state of affairs and who is answerable for the health of the populace. Udaipur's five lakes, Bhopal's upper lake, Dal lake of Kashmir and the Hussain Sagar in Hyderabad; all tell a story of human greed and indifference. The avarice continues

UDAIPUR

Defiled

Udaipur's five lakes depict the saga of degradation and the apathy of the state government and citizens

P L AGARWAL

UDAIPUR is a beautiful city surrounded by the Aravalli hills and five lakes — Pichola, Fatehsagar, Rangsagar, Swaroopsagar and the smaller Dudh Talai. Though outwardly Udaipur looks serene with its lakes and gardens, environmentally it is heading towards disaster and its residents face the threat of an epidemic from water-borne diseases. The environmental threat to Udaipur's lakes arises largely because of two interrelated sources: siltation and pollution. The siltation of the lakes has mainly occurred due to mindless deforestation, while their heavy pollution has been the result of continuing disposal of sewage.

Indiscriminate deforestation in the hills surrounding Udaipur and in the adjoining forests of Mewar region has meant that every year's monsoon washes down tonnes of silt into the lakes. It has been estimated that the capacity of Pichola is getting reduced every year by 0.93 per cent and that of Fatehsagar by 1.16 per cent. The life in terms of dead storage of the lake is hardly 28 years and in terms of gross storage, the life of Pichola is estimated at 97 years and of Fatehsagar at 72 years, by which time these lakes will be completely filled.

Open municipal drains full of raw sewage lead directly into the lake Pichola

T RAZDAN

Ultimate dumpyard

There are approximately 60,000 people living around the lakes and nearly 60 hotels dot their peripheries. The domestic sewage and waste water from the hotels is conveniently let into the lakes of Pichola, Rangsagar and Swaroopsagar. Defecation on the banks of Swaroopsagar is a common practice. The sewage system constructed around the lakes does not work and raw sewage is directly emptied into them. Solid domestic waste amounting to 20-25 tonnes per day is also dumped close to the lakes. This finds its way into the lakes during the monsoons. Besides, people living around the lakes continuously attempt to extend their personal property by encroaching upon the lakes. In addition, the 73 *ghats* on lake Pichola are mostly used by the public for bathing and washing which includes infected linen from hospitals. A large amount of detergent goes into the water, increasing its phosphate content.

Between 1978-82 a partial sewage system was constructed (without a sewage treatment plant) to cover 30-35 per cent of the population around the lakes. However, due to certain design limitations and improper maintenance, the system does not function and raw sewage flows directly into Pichola and Rangsagar (*See table: Sewer lines now*).

Clean-up actions

- **Finalisation of master plan of Udaipur city, setting apart adequate areas for construction of hotels and prohibiting new construction within 200m of the lakes.**
- **Diversion of all sewage and waste water from the lakes to a fully functional sewage system, which has one or more sewage treatment plants.**
- **Construction of a chain of toilet complexes around the lakes, the use of which should be made free.**
- **Construction of separate washing and bathing facilities away from the lakes.**
- **Disposal of solid wastes, including conversion into compost or bioconversion using vermiculture technology, on a permanent basis.**
- **Massive afforestation and construction of silt traps and anicuts in the catchment areas of the lakes.**

Besides, water treatment plants, which have a capacity of 24.1 million litres per day (MLD), generally treat 31.8 MLD — an overload of 32 per cent. There are a number of cracks in the filter beds and as a result suspended solids generally escape into the drinking water. A large amount of faecal coliforms, which is indicative of the presence of faecal matter, has been detected in drinking water during studies conducted by scientists from the M L Sukhadia University and the Rajasthan Agriculture University over the last 20-25 years. Besides, during treatment water is superchlorinated to remove impurities. This is known to produce trihalomethanes, which are highly carcinogenic chemicals. It is believed that Udaipur has an abnormally high incidence of cancer and the superchlorination of drinking water may be partly responsible for this. The poor quality of drinking water in Udaipur is resulting in the high incidence of water borne diseases such as typhoid, para-typhoid, amoebic dysentery, colitis, diarrhoea and viral hepatitis.

The pollution of the lakes has not only affected the health of the people of Udaipur. It has also practically wiped out several species of fish. The bigger carps are fast disappearing, leaving only minor carps, minnows and puntius.

The situation is indicative of the slow poisoning of the people of Udaipur. Unless there is a mass movement that makes the issue the focus of debate at the national level, and unless the government is made answerable for the utter neglect of the environment and the health of the people, the beauty of Udaipur's lakes will become a mere memory. ■

Superchlorination to purify the drinking water in Udaipur is resulting in higher incidence of cancer

A view of the dried-up lake of Pichola

T RAZDAN

Sewer lines now

The total quantity of effluents flowing into the lakes from 38 drains has been estimated at 6,000 m^3/day

Lake	No of drains	Effluents volume (m^3/day)
Pichola	25	3580
Rangsagar	8	1250
Kalalia talab (part of Pichola)	1	830
Swaroopsagar	4	340

P L Agarwal is the ex-chairperson of the Steel Authority of India Limited

Majestic lakes

Local chieftains constructed the lakes of Udaipur

Lake Pichola was constructed first between 1382 and 1418 by a Banjara chief and later an embankment was constructed by Maharana Udai Singh in 1560. While its original depth was 18 m, it is now reduced to between 4.5 and 8 m. Pichola has two beautiful island buildings — the world famous Lake Palace hotel and the historical Jagmandir. The catchment area of the lake is 127 sq km.

Lake Fatehsagar was first constructed in 1678 and later renovated in 1889 by Maharana Fatehsingh with the construction of a 720 m-long and 100 m-wide embankment. The lake is 2.6 km long, 1.8 km wide, has a water spread of four sq km and a shore line of 8.5 km. Its catchment area is 53.66 sq km.

The Rangsagar and Swaroopsagar lakes have been constructed as extensions of Pichola and these are further connected to Fatehsagar by a canal. Rangsagar was constructed in 1668 and is 0.523 km long and 0.233 km wide with a water spread of 0.136 sq km. Lake Swaroopsagar was constructed in 1844 by Maharana Swaroop Singh and has a water spread of 0.19 sq km. Dudh Talai is a smaller lake connected to Pichola and is situated at the foothills of Machla Magra.

BHOPAL

One lake, multiple demands

The upper lake, the 11th century lake of Bhopal, is dying gradually because of indiscriminate usage, indifference of the authorities and human pressure

BOBBY NAQVI

UPPER lake, which is locally known as Bada Talab was built by king Bhoj of Dhar (1000-1055) by constructing a massive earthern bund across the Kolans river in Bhopal, Madhya Pradesh. The lake which has a catchment area of 36.1 sq km, has become highly polluted primarily due to eutrophication. Its water spread too has either been replaced with silted land mass or covered with aquatic weeds which takes a turn for the worse during summer.

The continuing pollution has posed a serious threat to the quality and the effectively usable quantity of water from the lake for the city's public water supply scheme, which is already handicapped by the absence of an alternative cost-effective water source.

Eutrophication stalks the upper lake of Bhopal

More agricultural crops are found in the area rather than thick forests. As such, the catchment area, which is covered with black soil, is subject to severe erosion. Consequently, a large volume of silt and humus material has been carried into the lake by Kolans river and other rivulets entering it. In addition, agriculture residues from village areas and solid waste, including construction debris from residential and commercial areas, also find their way into the lake through the drains and streams, particularly during the rainy season.

Besides, it is estimated that 7,500 cu m per day of sewage joins the lake.The silting rate of the lake is estimated to be about 1 cm to 2.5 cm per year and the estimated sedimentation rate from the catchment area is to the tune of 3.6 ha m (hectare metre) per 100 sq km per year.

On the southern side of the lake, near Shamla Hills, an area of 14 sq km encloses the Van Vihar national park. As the park is separated from the lake and protected from human activities by a nine km-long stretch — Lake View Road — normal vegetation grows in the area, thereby preventing soil erosion from the hills. However, there is a lot of inflow of sewage into the lake in Koh-e-Fiza, the area around the Medical College hostels.

After the Bhopal gas leak, some of the deadly methyl isocyanate dissolved in the upper lake

Bacterial overload

According to a report prepared by Pradeep Shrivastav, reader in the department of liminology, Barkatullah University in Bhopal, the bacterial load in the lakes has shot up by 20 times between 1985 and 1993, pointing towards the degradation of water quality due to organic waste. Also, the total suspended solids has gone up from 39 miligram per litre (mgl) in 1965 to 90 mgl in 1992. Shrivastav, who has been monitoring the upper lake for more than a decade, said that the maximum depth of the lake was reducing at an alarming rate. The maximum depth was recorded at 7.31 m in 1947. In 1968, the depth was recorded at 9.14 m and it rose to 10.93 m in 1971. However, the catchment area of the lake has increased from 2.7 sq km in 1876 to 36.1 sq km in 1988.

Another noticeable finding was recorded in the report prepared by the state council of science and technology. The council conducted a study to analyse the impact of methyl isocyanate after the Bhopal gas tragedy on December 3, 1984. The study established that the lethal gas dissolved in the water of the upper lake. It noted that the visibility of lake water was reduced from 133 cm in 1977 to 100 cm in 1989 . Similarly, the dissolved oxygen in the lake water reduced from 8.8 mgl to 6.17 mgl in 1989.

Whose lake?

The absence of any guidelines from the state government on who actually owns the lake has resulted in a situation where various departments are busy in exploiting the lake and thus putting tremendous pressure on this beautiful water body. A proposal is pending with the government to bring the lake under the Ramsar Convention, which means that the multiple use of the lake for recreation, fisheries, drinking and for wildlife will be encouraged. But this is contrary to the objectives of the Bhoj Wetland Project (*See box*: *Rebirth*). Further, the Bhopal municipal corporation, which is also a part of the project, is planning to use the lake as the site for a multi-crore water sports club.

At a time when the state government is already working on a conservation

project, the proposed activities could prove to be disastrous for the lake. Moreover, a four-storeyed hotel that has been constructed barely 10 m away from the lake is ready to start functioning. The liquid waste generated by the hotel, which is situated right in front of the water treatment plant, is bound to be released directly into the lake, and probably very close to the point from where the water is taken out for treatment. Also, tourist activities promoted by the state tourism development corporation is disrupting the otherwise peaceful environment of Lake View Road leading to Van Vihar. "The lake is slowly converting into a Chaupati-like area (in Mumbai) due to the increase in tourist promotion activities," said an activist of Sadprayas, a voluntary organisation crusading for the protection of the lake.

Besides the need for creating a nodal agency that has absolute control over the lake, there is an urgent need of strong political will to prevent further pollution of the upper lake in the name of religion, tourism and sports. Only time can tell whether the objectives of the Bhoj wetland project will be achieved. ■

Bobby Naqvi is a freelance journalist based in Bhopal

KASHMIR

AMIN WAR

Paradise no more

The Dal lake, the quintessence of Kashmir, is today a pale version of its former self

THE Dal lake is dying. The lake has shrunk more than 15 km over the last 60 years. Siltation, direct inflow of sewage, encroachment and stagnant water have led to the gradual degradation of the once-serene Dal lake, situated more than 1,500 m above mean sea level in Srinagar.

A Rs 410 crore project to revive the Dal lake may only touch the tip of the iceberg

A feasibility study for a Rs 410-crore restoration lake project will initially focus on partial treatment of sewage from 1,400 odd houseboats and houses on the periphery of the lake. But environmentalists feel that the project, undertaken by the Urban Environmental Engineering Department (UEED), which manages the lake, would touch only the tip of the proverbial iceberg. Says M A Kawosa, Jammu and

Rebirth

The government announces a project to revitalise the dying upper lake

The state government's Environment Planning and Coordination Organisation (EPCO), has taken up a Rs 231 crore conservation project — the Bhoj wetland project — funded by Japan to revive the upper lake system.The project is said to be the largest ever taken up to conserve any static water body in the country. Experts have already expressed their apprehensions over the success of the project as the agencies involved in it are confused over the objectives. In fact, the various objectives outlined in the project are reportedly contradictory.

The primary objectives of the project are to conserve and manage the upper lake and to ensure the enhancement of the quantity and quality of water. But the basic problem lies in the secondary objectives, which include increasing the water storage capacity of the lake by desilting, minimising evaporation (which is 4,000 million gallons every year) and checking the inflow of sewage and waste water. To achieve the secondary objectives, the agencies will have to carry out deweeding operations either manually or by using machines. According to a study conducted by the department of liminology, 60 ha of the lake area falls within the notified area, which forms a potential habitat for migratory birds and is also the source of drinking water for herbivorous animals of the Van Vihar national park. Including the notified area in a deweeding programme would mean the violation of the Wildlife (Protection) Act, 1972.

Besides, removal of weeds from the lake is likely to result in the unprecedented growth of algae. The report cited the example of 1987, when EPCO had launched a campaign called the Sarovar Hamari Dharovar for the preservation of the lake. During that time, aquatic weeds were removed manually. This resulted in the sudden bloom of algae and in just three months it covered a considerable portion of the lake. Because of this, the water treatment cost increased sharply as the water filters used to get choked in just six hours. The report proposed biological control of weeds by introducing grass carp fish, which feeds on the soft portion of the weeds and thereby restricts their growth. But to do this, the authorities will have to regulate fishing in the lake and this may result in a conflict between the 400 fisherfolk families and the project agencies, the report pointed out.

Kashmir director of environment and remote sensing: "When we look back over the past 15-20 years, we find that with all the effort and money, we have not been able to solve the problem."

According to Jammu and Kashmir forest secretary A R Parrey, "The lake which covered an area of 25 sq km (in the early '30s) has now shrunk to 10 sq km as recent mapping shows." Since 1992 the lake has shown a 'red bloom' of organisms, denoting eutrophication or lake death. Similar problems haunt Kashmir's other lakes. Wular, an absorption basin for the flood waters of the Jhelum river, and an internationally significant wetland that is home to more than 20,000 waterfowl, has reached a critical level with regard to its hydrological and ecological conditions. The lake area has dwindled from the original 202 sq km to the present 24 km.

Unsavoury consequences

One of the serious impacts of the degradation of the lake(s) has been the gradual loss of a flood control system (*Down To Earth*, Vol 4, No 15). Said UEED chief engineer G M Zargar, "Dal has a role in controlling the Jhelum waters." Zargar says that there are frequent floods in the lake every year and the water level remains high due to inflow from feeder drains, local drainage, and springs from the lake-bed. Restoration plans are on for the Dal and Wular lakes. But the results are yet to be seen. One of the plans envisage the fitting of floating septic tanks to houseboats, by the New Delhi-based Centre for Research Planning and Action (CERPA). According to a CERPA official, "Sewage will be chemically and biologically treated in the tanks and partially treated sludge could be collected and removed." ■

The Hussain Sagar lake regularly receives domestic sewage full of myriad chemicals

HYDERABAD

Waste receptacle

The twin cities of Secunderabad and Hyderabad have converted the historic Hussain Sagar lake into a convenient effluent site

The stinking stretch of polluted water that separates the twin cities of Hyderabad and Secunderabad in Andhra Pradesh is the historic Hussain Sagar lake situated in the heart of the 400 year old Hyderabad city. The lake which once received unpolluted water from upper reaches of river Musi, now receives domestic sewage and myriad chemicals from 300 odd industries.

Four industrial estates are located in its basin — Sanathnagar, Balanagar, Kukatpally and Jeedimetla. These industrial estates drain untreated and partially treated wastes, some of which are toxic, into Hussain Sagar lake. This along with domestic sewage received from Picket, Kukatpally, Bolakpur and Banjara Hills *nullahs* (drains) together account for a daily flow of 28,190 cubic metres per day of waste into Hussain Sagar lake (*See table: Effluents galore*). Presently, the lake and its sediments is saturated with toxic chemicals ranging from phenols, benzenes, cyanides to toxic metals. The lake that served as a drinking water source during 1884 to 1930 for the city, now functions as a common anaerobic lagoon receiving an ideal mix of domestic and industrial wastes necessary for the biodegradation of industrial wastes.

The dying lake poses a serious health hazard due to ground water pollution along the Hussain Sagar watershed area. The concentration of nitrate in the ground water around the lake is reportedly high, ranging from 0-400 PPM (parts per million), which is several folds higher than the permissible World Health Organization (WHO) standard of 10 PPM. A study conducted by the author and others in 1993 revealed high concentration of toxic heavy metals in the ground water samples along the radius of 0-800 metres around the lake. The concentrations of lead was in the range of 1-25 microgramme/ litre (ug/l) and cadmium concentrations ranged from 1-27 ug/l. These concentrations are significantly higher than the permissible levels of 10 ug/l of lead and 5 ug/l of cadmium recommended by various agencies like the Indian Council of Medical Research and WHO. However, infiltration of various organic substances like phenols, substituted benzenes from the lake into the adjoining ground water is yet to be studied. Therefore, the potential risk of exposure to these chemicals and toxic metals to people residing adjoining the lake through ground water consumption is still not clearly understood.

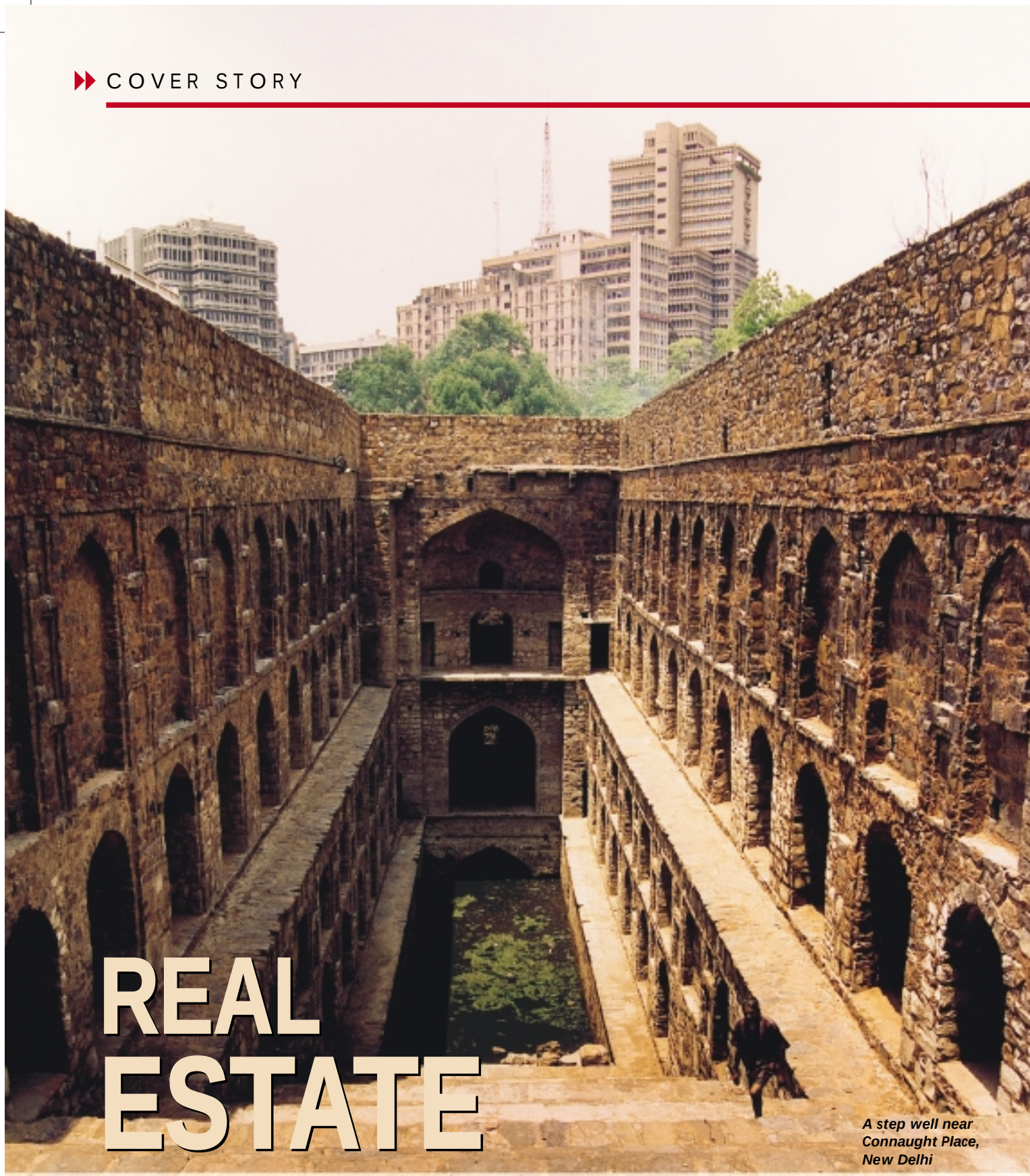
According to K Srinivasan, an environmental scientist, the ideal way of cleaning the Hussain Sagar lake and bringing it back to its pristine glory, is through diversion of sewage and industrial effluents, dredging of the lake and filling the lake with river Krishna's water, instead of sewage to maintain lake hydrology. While this solution appears to be most appropriate measure to revive the dying lake, it may prove to be cost prohibitive. Lake Osman Sagar and Himayat Sagar which provide potable water supply to the twin cities are also facing extinction due to rapid siltation and quarrying in the catchment areas. Dredging of these lakes is required to increase the water holding capacity of the lakes during monsoons.

R SRIKKANTH

Effluents galore

Hussain Sagar receives most of the twin cities wastes

Drains	Type of effluent (cubic metres per day) Domestic	Industrial
Bolakpur	6,820	-
Banjara Hills	4,550	-
Kukatpally	4,100	9,540
Picket	3,180	-
Total	**18,650**	**9,540**



REAL ESTATE

A step well near Connaught Place, New Delhi

PREETI SINGH / CSE

Lakes were critical for Indian cities. They prevented floods and recharged groundwater. Today, these holes in the ground are either lucrative real estate for builders, the last resort for slum dwellers, or garbage dumps. In the past decade, concerned citizens have approached courts across the country to protect lakes in cities. The courts have responded with dramatic verdicts, most notably in Ahmedabad. But which way now? Even if the lakes are protected, how will rainwater reach them in densely built up areas? Through stormwater drains. But who will keep them clean? Municipalities have already failed. Will Indian cities rebuild their water wealth? DOWN TO EARTH assesses

Concrete drama

Act, said the court. The government did not. The realtors are at the deep end now

SOPAN JOSHI *Ahmedabad*

SINCE April 18, 2001, new construction activity in Ahmedabad has virtually come to a standstill. The realtors of the commercial capital of Gujarat, one of the two most industrialised states of India, are desperate. Builder after builder talks about diversifying into other sectors to avoid bankruptcy. More than 700 applications for new buildings are pending with the authorities and no new construction is happening in an estimated 70 per cent of the city's land. The overall loss of business in real estate could be up to Rs 6,500 crore, estimates the president of Federation of Real Estate Developers Associations of Gujarat. And this does not include the 250-odd ancillary industries that depend on real estate development, he says.

Why? Because the Gujarat High Court acted in response to a public interest petition filed in October 2000 to protect lakes and increase water availability in the city (see box: *Courtspeak: The script*). After waiting for almost six months for the authorities to respond, the court restricted new constructions in a radius of 500-1,000 metres around 137 pieces of land that the additional resident deputy collector had listed as lakes in his affidavit dated November 20, 2000. It also directed the authorities to ensure that "lakes are used as lakes". At least 65 of these 'lakes' exist only on paper — from houses and schools to stadiums have been built on them with official sanction.

It is a bind for the Ahmedabad Municipal Corporation (AMC), the Ahmedabad Urban Development Authority (AUDA) and the state government. Officials and politicians say the order has held development to ransom. But they have no alternative plan to protect waterbodies, a fact highlighted by the court's exasperation. A lot of builders, and even the Indian Institute of Management, have filed affidavits, asking the court to modify its order. On April 5, 2002, the court formed a five-member committee of experts to advice it on the matter (see box: *People who count*). The committee faces the daunting task of finding ways to protect lakes when many of them have already been built upon. However, the issue had come to light not because of experts but citizens who approached the court. Like Shailesh Shah, a trader in pharmaceutical raw materials.

Shailesh Shah vs State of Gujarat

Shah lives in Mani Nagar in southeast Ahmedabad, which neighbours Chandola, the biggest lake of the city. During his childhood, he has seen crocodiles in the lake. Today, the lake has been reduced to a dry dustbowl with encroachments dotting its periphery. There are several illegal units that recycle waste automotive engine oil and plastics and dump refuse freely in to the 'lake'. Water shortage in the area is severe.

The summer of 2000 had seen widespread civic discontent due to water scarcity in several parts of the state (see 'Riots for water' *Down To Earth*, Vol 8, No 16; January 15, 2000).

COURTSPEAK: THE SCRIPT

9 OCTOBER 2000 Gujarat High Court issues notice to state government and Ahmedabad's collector and executive engineer of irrigation department. Demands the state's **water policy** and a comparative status of lakes.

21 NOVEMBER Court shocked that very few of the 204 lakes that existed in the city in 1960 remain lakes now. It directs the collector to place the status of encroachments on lake lands and to ensure that the remaining 137 lakes, as listed by the additional deputy collector, are used as lakes. **"We are required to pass this order on account of shortage of water."**

25 JANUARY 2001 Court refers to the alleged unauthorised construction at the Gopalnagar lake in Kalol. Demands detailed affidavits (see box: *Of lakes, farms and real estate*).

13 FEBRUARY **"It is a matter of great surprise that the authorities of the State are not taking keen interest in maintenance of lakes..."** Directs state government and AMC to produce a schedule to remove encroachment and recharge lakes by 26 February.

14 MARCH No reply by the state. "Despite the reports given to the Govt Pleader, affidavit is not filed and therefore, **we close the right of the State to file any further affidavit**." AMC granted one week to make its submission.

18 APRIL Court passes a dramatic **66-page interim order**. Directs authorities to remove unauthorised constructions and not permit any construction within **500 metres** of lakes smaller than 5,000 sq metres and **one km** if the lakes are bigger. Refers to lakes all over Gujarat: "**The State Government shall consider [the] direction in its true spirit... and shall make it applicable to all the lakes, ponds and waterbodies in the State of Gujarat**." Asks AMC to remove encroachers and allocate them land elsewhere. Demands report in six weeks of the action the government and AMC propose to take to remove encroachers and in what time.

15 MARCH 2002 Court says buildings affected by earthquake are not covered in the building restrictions. "The State Government, despite various directions... has not placed any material on record... the **Court was required to take up the matters because the State, Urban Development Authorities, Corporation, Local Authorities etc failed in discharging their duties** to maintain water-body as water-body and these authorities have forgotten the provisions of the Act and the circulars issued by the State Government itself."

22 MARCH Court again asks the authorities for a detailed action plan on recharging lakes.

5 APRIL "More than sufficient time has passed and no report is submitted by the Government." Court worried about over-extraction of groundwater. "Importance of **catchment area** cannot be forgotten and lost sight of. In the absence of catchment area, it is difficult to get the water collected in the lake/pond. In view of **haphazard and unhealthy development**, it is not possible to get the water collected in the lakes." **Forms a five-member committee of experts**.

19 APRIL Court is peeved that AUDA has granted development permissions in 129 cases, contrary to the court order. AUDA chairperson Surendra Patel asked to tender an **unconditional apology** and **scrap** the building permission. Patel is asked for an undertaking that he will be **personally liable if any of the 129 parties demand damages**.

DEATH BY DEVELOPMENT

The Ahmedabad lesson: wipe out lakes and you will face water scarcity and seasonal floods

In 1960, Ahmedabad had at least 204 lakes. Today, almost all have been built upon, encroached or left to disuse. The present high court order covers 137 lakes. And at least 65 of them have constructions like housing apartments or a stadium, all approved by authorities under various town planning schemes.

With rapid urbanisation, village after village around got assimilated in the city, an all too familiar story. The town planning schemes didn't take into account the natural drainage patterns and the topography of the area. This led to two things. Rainwater that earlier flowed into lakes and other low-lying areas now got impounded near new residential areas, causing seasonal flooding and waterlogging. Also, rainwater stopped reaching lakes, making them prime real estate for encroachers or builders or became garbage dumps. The new urban centres relied on piped supply of water or tubewells. The water table kept falling as paved areas prevented percolation of rainwater. Today, tubewells mining depths of 180-250 metres are quite common.

"If you superimpose the water table data on the topography, you find out where not to develop urban centres. Dense development should not be allowed in low-lying areas and these places should be kept as open spaces or green belts in town plans," explains Nimesh Patel, architect and town developer. Mansee Bal, research assistant at the Centre For Environment Planning and Technology (CEPT), Ahmedabad, has been working since 1998 on a paper that shows how the lakes of the city can be revived and developed as open spaces. "The contour map of the region shows that the general slope in the area is very low... That means the drainage pattern of the area is highly sensitive to any human intervention," writes Amit Kakde, engineer and who has written a research paper for CEPT entitled 'Framework for Management of Water Harvesting Structure – A Case Study of Ahmedabad'.

CITY OF F(L)AKES

The 137 lakes of Ahmedabad, as listed by the collector's office. 65 of these have been already been built upon, says the AMC

Source: Ahmedabad Municipal Corporation

According to AUDA's *Revised Development Plan 2011*, the city's 4.6 million people need 221 million cubic metres (mcm) of water in a year; the city draws 200 mcm/year from tubewells, against a safe yield of 80 mcm/year. By 2011, the water demand is estimated to climb to over 300 mcm/year. The entire region under AUDA depends on groundwater. The water table is dropping by 2-3 metres per year: It was 12-15 metres in 1940, 60-80 metres in 1984, and 100 metres in 1996. And there is too much fluoride in the groundwater.

Yet on July 13-14, 2000, when it rained 508 mm in 24 hours, there was widespread flooding in the city's suburbs. And then water scarcity returned as soon as the monsoon got over — so much so that it became a political issue in the September 2000 elections to the AMC. The BJP lost control of the AMC for the first time in 13 years to the Congress party.

Now Shah also runs a civic action group that is ideologically affiliated to the BJP. Concerned about water scarcity and government inaction, he along with 69 other residents of the area collected Rs 1,000 each towards legal fees and filed a public interest petition. They pleaded that

- The government of Gujarat present its water policy;
- Provide land records of big and small lakes in and around Ahmedabad as on (say) 1960 and their present status;
- Remove encroachments from the Chandola lake; and
- Desilt, revive and recharge the Chandola.

Petitions were also filed to revive the two other lakes: Lakhudi and Memnagar. The court combined the matters. Shah recalls the court commending him for raising the issue. But, he says, he would never have approached the court if he'd known that his petition would lead to restriction on building activity. He says he tried to withdraw the petition, but the court refused. Several of his friends have rebuked him for what his actions have led to, though he denies receiving threats from builders.

One result of the order is that even realtors

Real estate, real politik

A senior journalist, who has covered politics for more than three decades, says that if he were the editor of a daily newspaper, he'd have a reporter regularly covering the real estate beat because that's where the real politics lies. Surendra Patel, chairperson of AUDA, is also the influential state-level treasurer of the BJP. In 2000, the BJP government repealed the Urban Land Ceiling Act of 1976, releasing a lot of formerly disputed real estate for development.

In September 2000, after the court had ordered AMC and AUDA to crack down against illegal constructions, the state urban development minister went on record to say that the buildings should not be demolished. The municipal elections were round the corner at that time. Two months later, the court ordered disconnection of electricity connections to 150 buildings for non-compliance with fire prevention and safety norms. The issue became a law and order crisis with widespread protests and violence against the order. The January 2001 earthquake showed how builders had flouted norms. And after the high court restricted new construction around lakes, the General Development Control Regulations (GDCR) were modified, allowing constructions nine metres away from a waterbody.

Realtors explain that the business became big after the textile mills of Ahmedabad closed in the late 1980s. With economic liberalisation bringing in a lot of money in the early 1990s, real estate prices went through the roof, peaking in the mid-1990s, and then falling again. *Down To Earth* spoke to some builders to understand how the sector operates. On the condition of protecting their identity, they explained how the builder-politician nexus "can work". It is by no means impossible for builders to have prior information on which area is being earmarked for development. They *can* buy land from farmers in these areas at rates of agricultural land, and get incremental value once the land is included in a town planning scheme (see box: *Death by development*). The builders point to at least three clear ways to appropriate lakes.

- Lakes usually belong to the revenue department, and revenue land is the easiest to encroach. Once squatters take over, they obtain political patronage in return for votes.
- The land use is legally altered in the government records to make room for other public utilities like a stadium or a park or a school. It includes building houses for poor people. But once construction begins, the builders *can* step in and create 'stock', selling it at market rates.
- It was a common practice earlier in villages to grant rights to people to harvest produce from lakes, for example, water chestnut. Over a period, such lands got registered in their name. Builders purchase these lands and develop property, but this requires the collusion of the village *sarpanch*, the circle inspector, or officials of the revenue or urban development departments.

Precaution: a forgotten principle

Almost all the people who spoke to *Down To Earth* — town planners, architects, builders, officials — were critical of the court order. They questioned the scientific basis of restricting new construction as most of the area has already been built upon. But then nobody has another figure that is based on science. Besides, the order cited the Supreme Court's ruling in the Surajkund and Badkal lakes case, in which the apex court had restricted all new constructions in a five-km radius (see p36). Nobody was appreciative of the precautionary principle in the absence of any concrete proposal by the authorities.

Another obvious question: if the powers that be are convinced that the court order is flawed, why haven't they asked for its modification? Apart from requests to permit reconstruction of structures affected by the earthquake, *Down To Earth* could not find in the court papers any mention of a move from the authorities for a modification of the order. The AUDA chairperson said that the authority requested the court to modify the order. But he avoided sharing the paperwork on this with *Down To Earth*.

Journalists who have covered these issues for years say the authorities want the court order to collapse under the weight of mounting public pressure. Builders talk about labourers' woes due to loss of employment, who are in any case exploited and underpaid. The AUDA chairperson and BJP treasurer said it was wrong to raise the question of any pressure tactic to provoke public anger against stopping of development projects. He retorted: "If the court order is not right, development comes to a halt. We can't grant development permissions on 95 per cent of the land. What's the point? How will the city develop?" He questioned the logic of stopping development merely for lakes. He said the court overlooked the public interest litigation (PIL), and that he is pained at the fact that the

have started talking water harvesting

PEOPLE WHO COUNT

The court's committee of experts

MAYUR PANDYA: Chairperson of the committee. High court lawyer. Also chaired a Gujarat High Court committee set up to investigate pollution of Khari river near Ahmedabad in 1995.

SUDHA ANCHALIA: Convenor of the committee. Principal secretary to the department of urban development and housing.

M V PATEL: Retired professor of civil engineering and head of the Centre for Water Resources Management at the L D College of Engineering, Ahmedabad.

M S PATEL: Secretary to the department of Narmada and water resources. Engineer by training.

BIMAL PATEL: Architect, town planner and managing director of Environment Planning Collaborative, Ahmedabad.

OF LAKES, FARMS AND REAL ESTATE

How to create real estate out of waterbodies

"...it is not made clear by the AUDA (Ahmedabad Urban Development Authority) as to what was the necessity of changing the purpose for which the land was reserved, namely from recreational to residential zone. In the absence of any specific reason assigned for such proposed change it is a matter of guess whether such a change was made keeping in view the interest and protection of the wild life and the environment or there was some direct or indirect pressure of the builders and private contractors who were interested in utilising the land for raising constructions..."

Thus ruled the Gujarat High Court in what has come to be known as the Gopalnagar lake case. Sandeep Brahmabhat, a postal department employee and a bird watcher, filed a public interest petition to prevent the development of a 'low-lying' area at Kalol, 30 km west of Ahmedabad in April 11, 2001. This area was the course of the rivulet Vyantri, says Brahmabhat, adding that at least 27 species of birds have been spotted there. "Today the rivulet is as good as dead. Industrial units dump their effluents in it," he says. In revenue records, the lake was earmarked as agricultural land. But residents who have lived on the periphery of the 'lake' for 33 years say they have never seen the land being cultivated: "It used to have water throughout the year earlier, and various birds could be seen. Even now, water accumulates here after the monsoon, and the birds stay here as long as the water does. I have no clue how the land was granted to the farmers." The court referred the case to the Gujarat Wildlife Advisory Board. It ruled that there was not enough evidence to show that the land was a 'lake'. The land remains with its present occupiers: some builders who had bought it from farmers. Brahmabhat wants the government to buy the land and make a bird sanctuary there.

When this correspondent visited the area, a tractor was ploughing the land to wipe out the cracks that appear at the base of a waterbody when the water dries up. Nayan Patel, the well-built builder, was directing the operations. He claimed the land has always been used for agriculture. A gun hanging from his waist, he used the choicest invectives in Hindi and Gujarati for Brahmabhat and openly threatened to do 'things' to his family. He pointed to the dry land and asked: "How can birds come here? There's no water here. Groundwater table is at 250 metres. There are no birds in this area, not till the Nal Sarovar, which is a good 20 km away." This correspondent saw a flock of at least 200 lesser flamigoes at a sewage-filled village tank in Borisna, a short walk from Gopalnagar.

court has shut its eyes to the fundamental question of encroachment. He demanded a stronger order from the court to be able to remove encroachments.

The mayor of Ahmedabad, Himmatsinh Patel, when asked about the administration's failure in removing encroachments, said: "Encroachment *hai hi nahin*" (There are no encroachments). When asked about the widespread encroachments around lakes, he said the encroachers return soon after municipal authorities remove them and that it was not possible to keep out the temporary establishments of migrant workers, who are helpless and harmless anyway. When asked about the waste oil that is illegally dumped on the bed of the Chandola, he said it was the duty of the environmental authorities to stop such activities. He also indicated that cities do not usually have lakes, not like in villages, and that wherever you have lakes in the city there's bound to be filth. "Where will the water for lakes come from in a built up area?" he questioned. But when asked how he planned to recharge lakes, he said: "The lakes have been dug up and left there. If God so wishes, water will reach the lakes." As for floods in the city durng monsoon, he said that not much can be done in the case of a natural disaster.

VIVEK DESAI

Sandeep Brahmabhat, the main petitioner of the Gopalnagar case, watches a flock of lesser flamigoes at the Borisna tank

Most of the lake land in the city falls under the revenue department. The collector of Ahmedabad could not be contacted. But it is worth noting that the advocate general of Gujarat has appeared in the court on behalf of AMC and the additional advocate general has appeared for AUDA. A government pleader has represented the state government in the case.

As things stand, the role of the committee will be crucial in deciding which way the case proceeds. Another factor that will have a bearing on the case is that one of the two judges on the two-judge bench, B C Patel, who took a keen interest in the matter, has been shifted to the Jammu and Kashmir High Court. A new judge will take his place after the court's summer vacation ends. Watch this space for what happens next. ■

Tourism deal

A hospitality outfit attempts to restore Mansagar lake

BHARAT LAL SETH *Jaipur*

Located in the Jaipur-Amber tourist corridor, the Mansagar lake is called the Jal Mahal lake because it houses the 18th century monument after which it is named. The lake was built after a famine in the late 16th century. As Jaipur grew into a tourist destination, the lake suffered. So did the monument. Soon, tourists started giving it a miss.

The lake gradually became a receptacle of Jaipur's garbage and untreated sewage. Things began looking up in 2004, the year the state government roped in a private developer on a 99-year lease to fund the restoration of the lake and the monument. This is the first such initiative in the country.

The lake, the private developer hopes, will be back on the tourist map, with a number of additions—resorts, luxury and budget hotels, foodcourts, gardens, public parks, entertainment centres—in about five years. These will be built on 100 acres (about 40 hectares) of prime lakefront land at the southend. This is dependent on the state government giving the go-ahead for construction, which the private developer hopes will come through in a few months.

The revenue from tourism would be tied with the lake's health. For this both the state government and the Jal Mahal Resorts Private Ltd, the developer, have invested money and engineering works. The state wants the lake and the monument to be entry points into the capital.

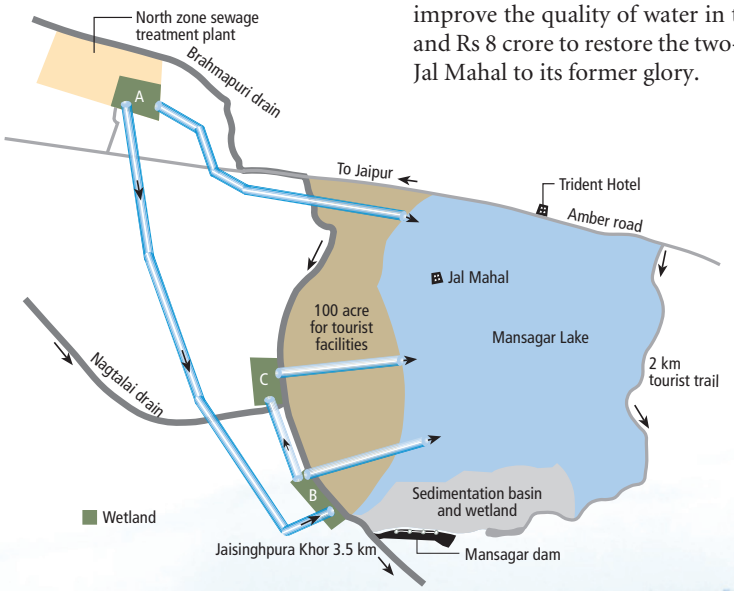
In 2001, a state government body, formed to draw sustainable development projects along commercial lines, submitted a project report on the lake. It recommended private players.

A year later, the Union environment ministry appointed the Jaipur Development Authority (JDA) the nodal agency for Mansagar's restoration under the National Lake Conservation Plan. The ministry sanctioned Rs 24.72 crore. It gave JDA Rs 17.3 crore and asked the state government to raise the remaining amount. JDA built a two-km tourist trail and a km-long promenade, among other things.

In 2004, the state invited bids from private companies and leased the lake to Jal Mahal Resorts, after which the company and JDA worked together. This work included diverting the sewage channels so that they do not drain into the lake directly (see box). Four years later, the private developers paid JDA the first lease of Rs 2.5 crore. Jal Mahal Resorts has spent about Rs 25 crore to improve the quality of water in the lake and Rs 8 crore to restore the two-storied Jal Mahal to its former glory.

Lake restoration plan

Should be completed in five years



Sources of pollution

The Mansagar lake's catchment is 23.5 sq km, two-fifths of this is urbanized—the source of pollution. Untreated sewage and stormwater from the north drains into the lake, through the Brahmapuri and Nagtalai nalas.

Brahmapuri has a sewage treatment plant that can handle 27 million litres per day (mld). But Jaipur sends down 50-60 mld sewage. A new facility to treat 50 mld is in the works. In 2007, Jaipur Development Authority realigned the drains and channelled sewage downstream. The state then cleared the private developer's plan to segregate a part of the lake for sedimentation basin and wetland. Stormwater, solid waste and sewage now find their way to the sedimentation basin. The basin, though, requires dredging periodically.

This is a mockery of lake restoration, said Brij Gopal who retired from the School of Environmental Sciences, Jawaharlal Nehru University, Delhi. "Why segregate a portion of the lake with a settling basin? It looks like a business plan that requires the perpetual cost of dredging," he said.

The private developer said they wanted to develop the lake as an ecosystem conducive to aquatic vegetation, fish and migratory birds. The aquatic plants naturally filter pollutants, doubling up as fresh feed for birds, said Rajeev Lunkad, programme director of Jal Mahal Resorts.

But, after heavy rains, the basin cannot hold the volume, releasing it downstream. This floods the village of Jaisinghpura Khor, 3.5 km downstream. The canal narrows to a third of its width when it reaches the village, said Jal Kapadia, team convenor of an expert group formed for lake rejuvenation. The irrigation department is planning to increase the carrying capacity of the canal.

The sedimentation basin, however, has taken away the stormwater that flowed into the lake. And with the diversion of the channels, it does not get partially treated sewage even. This has created water shortage in the lake. Jaipur Development Authority has decided to treat 7.8 mld of sewage and let it into the lake. There are plans to further treat the water to meet water quality standards. This would then course through four hectares of wetlands before reaching the lake.

"Post restoration work, the common moorhen, a resident species, is also breeding in large numbers at Mansagar this year," said Harsh Vardhan, who has been conducting an annual birding fair since 1997 to draw attention to the lake.

Activists are against privatization and say since the government does not own the lake, it has no right to privatize it. The government is merely a custodian of the lake, said Leo Saldanah of the non-profit Environment Support Group in Bengaluru. The non-profit has protested privatization of lakes in Karnataka (see 'Bangalore lakes leased out', *Down To Earth*, May 15, 2008).

The private developer argued it has added value to the project. "The Rs 3-4 crore we have spent on technical expertise and consultants to devise strategies to revitalize the ecosystem was not a part of the deal we signed with the state government; it was necessary," said Rajeev Lunkad, programme director of Jal Mahal Resorts. "The lake is of utmost importance as our future operations depend on the quality of its waters."

Rajasthan attracts about 650,000 national and 175,000 international tourists each year. Travellers must extend their stay at the state capital, said Gun Nidhi, general manager of Rajasthan Tourism Development Corporation. "For this to happen, we need to pack their itinerary. The project is the injection this city needed."■

Appetite for sewage

Bacteria feed on pollutants in sewage, kill odour, but are they a complete solution?

BHARAT LAL SETH

Uttar pradesh chief minister Mayawati reportedly complained recently of foul odour from an open drain with sewage near her Kautilya Marg residence in New Delhi. There was no formal complaint, just her word. The New Delhi Municipal Council had to act. On November 14, at Rs 8.5 lakh annually, it set in motion a remedy: a tank that releases microbes to treat sewage.

One part microbes is added to 40 parts of untreated groundwater in the tank and the solution is released into the drain. The wastewater in the drain is now visibly cleaner, and without the foul smell. The drain requires two-and-a-half litres of the potion everyday, at Rs 600 a litre.

Called bioremediation, this is the microbiological approach to treat sewage. The microbes accelerate decomposition of organic matter, doing in weeks what nature would in decades. Companies and municipalities that have tried this method claim advantages over existing systems, involving treatment plants. These need money, electricity and land, which are a cause for concern, said Suresh Rohilla, head of the Living Ganga Programme of WWF-India.

The microbial solution unit takes very little time to set up and does not usually require civil works or skilled labour. With over 100 bioremediation pilot projects completed in India, the technology must be standardized, said Rohilla. Besides, sewage treatment plants have failed to check discharge of untreated waste into water bodies, he added. Bioremediation proponents therefore see bacterial strains' role in cleaning the Ganga on which the Centre has spent over Rs 3,000 crore so far, with very little result.

More than 3,000 litres of untreated sewage is pumped daily in the Ganga basin, said Mamata Tomar, director of J M Enviro, a company that has completed over 50 pilot projects over the past five years. She deducted the amount that can be treated in existing plants from the total amount of sewage in the basin, and arrived at the figure. If this amount were treated with their patented pool of microbes, it could save more than Rs 100 crore annually that otherwise would be used to operate treatment plants, the company claimed.

The government though is undecided on the methods to control pollution. "Bioremediation will have a definite role in future," said R C Trivedi, former deputy director of the Central Pollution Control Board. "Because land is at a premium now." This would require that the Centre sanction it.

Not so easy

Central Public Health and Environmental Engineering Organisation (CPHEEO), a Union urban development ministry body, sets norms for water supply and sanitation in Indian cities. Its primary objective is to achieve 100 per cent sewerage network coverage.

PHOTOGRAPHS: MEETA AHLAWAT / CSE

Figures would vary on scale and company

"Treating drains is against the existing policy," said Sankaranarayanan, advisor to CPHEEO.

Then there is the small matter of federalism. Water supply and sanitation is a state subject; municipalities control it. The Centre's role is advisory. Besides, bioremediation is an unproven technology, said Sankaranarayanan. "We believe it is a temporary solution."

He is not the only one who is sceptical. "I first heard of these claims in the late 1970s and we had some trials in Thames Water," said David Johnstone, then general manager of the water company in the UK. Their experiments concluded there was little or no improvement and that it was an easy way to throw money down the drain.

More proof needed

Companies offering bioremediation solutions exchanged notes with scientists at a recent conference in the Indian Institute of Technology, Kanpur. "Our aim was to have an academic debate and find ways to standardize the use of the technology, ensure competition and transparency in costing," said Vinod Tare, professor at the institute. This did not happen, he said, because the companies could not look beyond narrow commercial interests.

The institute, in an experiment on bioremediation, found the results were unreliable. A lot depended on the temperature, pH, retention time, flow rate and changing characteristics of raw sewage. "Let's not confuse pollution control and abatement. Existing technology can be used to clean controlled systems such as lakes but not rivers," said S R Wate, deputy director of the National Environment Engineering and Research Institute in Nagpur.

Tomar disagreed: "We work out a daily dose. Fresh pollutants in a stream are dealt with a fresh batch of microbes. We can also construct concrete structures such as check dams to increase the retention time of drains, which have a high flow rate."

Microbes accelerate decay of organic matter, doing in weeks what nature would in decades

Biomedical tanks on a drain

Hybrid approach?

In an abandoned sewage treatment plant in Delhi, J M Enviro treated 50 million litres of sewage each day for six months. Satisfied with the results, the Delhi Jal Board extended the company's contract. Tomar was not surprised. Just the savings on electricity was Rs 63 lakh.

The maximum energy in a treatment facility is used to run aerators, installed to increase oxygen levels for bacterial growth and survival. "In treatment plants the required dissolved oxygen levels for bacteria to function is 2-3 mg/l, while our consortia of patented microbes can work at even 0.5 mg/l," said Aditya Singhal of Enviro-Way, a Canadian company which expanded its operations to India in 2003. As a result the power requirement reduced by up to 50 per cent, he added.

As a thumb rule most conventional sewage treatment plants require a retention time (from inlet to outlet) of 24 hours. "The live strains of microbes we add require eight hours to do the job," said Singhal. By reducing the retention time more sewage can pass through the treatment plant each day. This too saves on power.

Bioremediation works

In a recent experiment, conducted May through July 2009, a 2.5 km stretch of a drain in Kanpur was handed over to J M Enviro. Based on flow and pollution load at select dosing points, the company calculated the quantity of the microbial solution to be added. During this period about eight litres of bacteria medium was added to the flow everyday at Rs 600 per litre. For the entire pilot duration, eight million litres of daily flow was treated to pollution control board standards at Rs 6.1 lakh.

"Although the role of our biological product is to control odour, the live bacterial strains break down complex organic compounds which positively impact the pollutants and organic load," S B Sharma, general manager of J M Enviro said. The treatment met with approval from the then commissioner of the Kanpur Municipal Corporation who visited the site. Three laboratories, including one private laboratory deputed by WWF-India, corroborated the results. Kanpur has plans to increase its sewage treatment capacity for which the electricity demand would be Rs 20 crore each year. "If the wastewater of Kanpur was to be treated using bioremediation, the annual expenditure would be Rs 8 crore," said Mamata Tomar, director of J M Enviro, challenging the existing paradigm.

The appeal of bioremediation might increase as the price of the products reduces in the near future. Manufacturing units are currently located overseas, and import duties are levied on their products. But with the expansion of business potential in India, firms are planning to manufacture the patented products in India. J M Enviro is confident of setting up a unit in India by 2010. Company officials said this would cut their quoted prices by half.

The technology's potential for sewage treatment cannot be demonstragted unless it is given a fair chance, companies argue. ■

Activist Akhil Gogoi (left) and minister Jairam Ramesh discuss dams

RITURAJ KONWAR

Downstream impact

Protests against dams are snowballing into a political movement in Assam

ARNAB PRATIM DUTTA *Guwahati and Tezpur*

ASSAM is on the brink of a movement, like the one that ended with the 1984 Assam Accord. This time the concern is not illegal immigrants but dams proposed upstream in Arunachal Pradesh.

In the past year and a half people in Assam have held a number of protests. The latest one was on September 10 when Union Minister of Environment and Forests Jairam Ramesh visited Guwahati to consult academics, activists and student and political leaders on large dams, particularly a mega hydel project under construction on the Subansiri, a tributary of the Brahmaputra. The 2,000 MW Subansiri Lower Project is the biggest of the three dams under construction in Arunachal Pradesh.

The protest led by the two biggest pressure lobbies in the state—All Assam Students Union (AASU) and Krishak Mukti Sangram Samity (KMSS)—signals no-holds-barred attempts in the future to stop Subansiri Lower. Asom Gana Parishad (AGP), the main opposition party in the Congress-ruled Assam, has also joined the agitation.

At the heart of the protest and Ramesh's visit is the impact on Assam of the dams planned in Arunachal Pradesh. The state has signed 168 memoranda of understanding with private and public companies to develop hydropower (see 'Electric rush', *Down To Earth*, May 15, 2008). These projects are on the Brahmaputra and its tributaries. "Arunachal Pradesh is set to gain revenue from these projects, but Assam will be the victim if anything goes wrong," said Samujjal Bhattacharya, adviser to AASU.

The Subansiri effect

Dams in Assam got politicised after work on Subansiri Lower began in 2005. Till then discussion regarding dams was limited to academics and a handful of ecological activists and lawyers. In 2004, the Supreme Court had allowed Subansiri Lower but banned more dams on the Subansiri because no one had assessed their cumulative impact downstream. The following year AASU led protests in Dhemaji and Lakhimpur districts demanding an assessment of the impact of Subansiri Lower. The agitation led to a tripartite meeting between AASU, NHPC (the company building Subansiri Lower) and the Assam government in December 2006, said Bhattacharya. At the meeting it was decided that a team of experts from Gauhati University, Dibrugarh University and IIT Guwahati, would assess the downstream impact.

On June 28, 2010, the team recommended lowering the height of the dam and making technical changes in its structure to increase river flow (see 'Reduce Subansiri dam height: panel', *Down To Earth*, July 31, 2010).

"So far AASU has only demanded downstream study. It is yet to take a stand on whether it opposes big dams," said Arupjyoti Saikia, professor at the department of humanities and social sciences, IIT Guwahati. But the organisation that claims to represent farmers and fishers in the state, KMSS, has made it clear it will not allow dams in Arunachal Pradesh. Akhil Gogoi, its president, claims the support of nearly 500,000 fishers dependent on the Brahmaputra. He said his outfit will agitate peacefully but as a last resort would not hesitate to block roads leading to Arunachal Pradesh.

Initially, concerns of downstream

impact did not evoke much response from political parties. On two occasions, in 2007 and 2008, the concerns were raised in the Assam Assembly but no party showed interest, said AGP MLA Girindra Kumar Baruah.

In July last year, the opposition forced the minister of power and industry, Pradyut Bordoloi, to reply to a calling attention motion on Subansiri Lower. A debate on big dams ensued, with emphasis on Subansiri Lower. "The treasury benches joined to raise concerns about downstream impact," said Membar Gogoi, Congress MLA from Teok.

After the debate the Assembly decided to set up a multi-party panel to look into the impact of Subansiri Lower and Ranganadi hydel project in Arunachal Pradesh. The committee, chaired by Membar Gogoi, submitted its report on July 17, 2010. "We have asked NHPC to stop work till it acts on the recommendations of the expert team (set up in 2006)," Membar Gogoi said.

The sudden surge of political interest in dams is because of two reasons: Assembly elections in 2011 and growing anti-dam agitation. Today about 40 organisations in districts downstream of the Subansiri reservoir are working against mega dams. "No political party wants be seen as a supporter of Subansiri Lower," said a senior AGP worker.

Congress dodgy, AGP aggressive

But the state government is in a bind. On the one hand, elections dictate it respect the popular sentiment. On the other hand, it cannot go against the Congress-led government at the Centre which wants dams. Although the Assam power minister presided over the 2006 meeting between AASU and NHPC that led to the setting up of the expert group, the state government refuses to acknowledge the group's report as official, said a power department official. The government has only now, after seeing the AGP-led opposition, decided to oppose dams in Arunachal Pradesh till downstream concerns are addressed, he added.

AGP sees votes in opposing big dams. Baruah believes the dams will become a big issue in elections, especially in the districts immediately downstream of Subansiri Lower, including Lakhimpur and Dhemaji. In January this year, the party held consultations in Guwahati to understand downstream effects. According to witnesses, former chief minister and AGP leader Prafulla Kumar Mahanta sat for two days listening to activists and academics. "First, it was difficult to explain party leaders the downstream worries, but after two days they were convinced the issue could get them votes," said an academic who was part of the consultations. AGP has followed up the talks with a rally near Subansiri Lower at Gerukamukh in Lakhimpur in September.

The Assam government is catching up. In August while addressing the power ministers of the north-eastern states in Shillong, Bordoloi expressed anguish over wanton building of dams. According to sources close to the minister, a day before the meeting Bordoloi was tutored by the expert group that had recommended lowering the Subansiri dam's height. Bordoloi, who is also the spokesperson for the state Congress, has since become more vociferous in his critique. Recently, writing in a national weekly, Bordoloi criticised the Arunachal Pradesh government for signing contracts with fly-by-night operators for building dams without a comprehensive assessment of the fallouts.

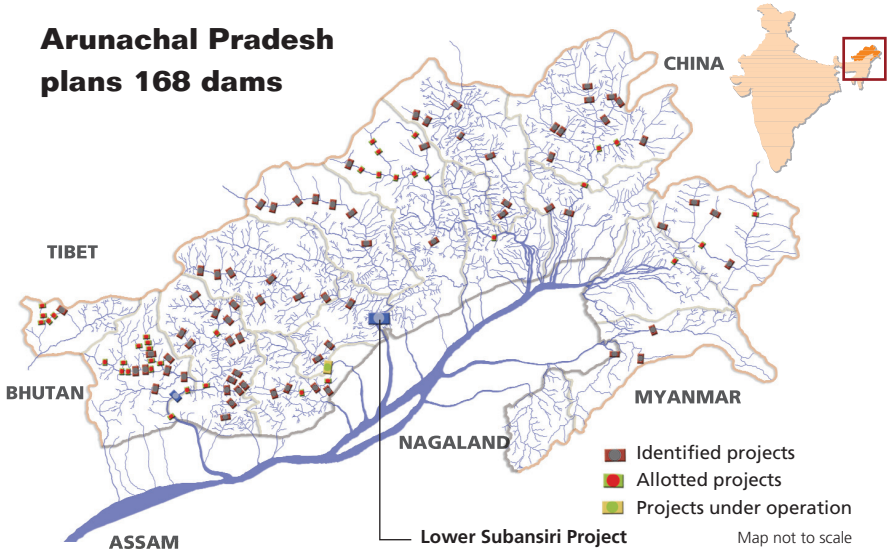
Arunachal Pradesh will gain revenue but Assam will be the victim if anything goes wrong with the dams

— SAMUJJAL BHATTACHARYA, adviser to AASU

According to sources in the power ministry, the Assam government is trying to implement the report of the inter-ministerial group on hydropower in north-eastern states. The report, published in February this year, recommended sub-basin level studies for the Subansiri and Dibang rivers by the Central Water Commission. Neeraj Vagholikar of Kalpavriksh Environmental Action Group in Pune, who is working on dams in the Northeast, said sub-basin level studies are mere academic exercises because the group's report state's clearance of projects on these rivers will not be held up till the studies are completed.

Even as Ramesh left Guwahati with the promise of assessing cumulative downstream impact before clearing dams, a storm is brewing on the banks of the Brahmaputra in Tezpur. A barge with turbines for the Subansiri Lower is stationed at Jahaj Ghat. It cannot be taken to the dam because KMSS and AASU have threatened an agitation. Tularam Gogoi, president of the Lakhimpur unit of AASU, said people are on standby. They will hold sit-in on the highway linking Tezpur to Itanagar in Arunachal Pradesh if the state administration or NHPC tries to move the turbines before the recommendations of the expert group are followed. ■

Arunachal Pradesh plans 168 dams



SAYANTONI PALCHOUDHURI / CSE

Watertight

Rate water fixtures for efficiency to cut wastage

SAKSHI CHADHA DASGUPTA

Tapasya Mohan, a 29-year-old executive in a telecom company, recently purchased a refrigerator. She did not go by looks but the five-star label on the fridge for energy efficiency. She did not mind paying more; the salesman convinced her she would save more in the long run on her electricity bills.

Mohan wishes there was a similar rating system to help her choose a water closet to replace the leaking cistern in her bathroom. She gets water supply for only two hours in her Gurgaon home near Delhi and the leaking cistern drains her storage tank by evening. Mohan will have to wait if she expects help in making an informed decision. Water efficient taps and closets are available in the market, but they are not graded.

Makers of sanitary ware and fixtures rely more on sleek design and looks to attract customers. "Only one in 20 customers visiting our outlet enquires about water use. Most customers are only bothered about looks, design and cost," said Gautam Dhingra, sales head of a Parryware Roca showroom in a posh locality in Delhi.

Low awareness, low demand

Parryware's sales manager for northern India, Pankaj Rai, said it is mostly hotels and new office buildings that use water efficient fixtures.

Known brands like Parryware and Hindware now sell dual-flush toilet models where the user can opt to press the half-flush button that flushes three litres or the full-flush button that empties six litres (see table on *p*33). The single flush cisterns use 10 to 13 litres of water. A good number of customers still buy big cisterns, said Rai.

Other available water-efficient fixtures include taps with aerators and flow fixtures, sensor taps that shut off in a few seconds, showers with flow regulators and waterless urinals. A person using faucets with aerators (to spread the water flow into small droplets rather than a jet stream) and flow controls can reduce water usage by 50 to 60 per cent.

If Mohan were to get her kitchen and bathroom fitted with water-efficient fixtures, she could save 415 litres water a day, if one goes by Tata Consulting Engineering's 2009 study of households. The saving is high considering the average water availability in India is just 100 litres per person a day (lpcd) against the prescribed standard of 135 lpcd. Of this, nearly 30 per cent water is used for flushing and about 50 per cent is used for bathing, washing and cleaning.

The informal market that caters to 50 per cent customers in small towns and cities also provides water-efficient fixtures. Nitin Jain, proprietor of Prayag Sanitarywares, a dealer in Delhi's Paharganj area near the walled city, said dual flush pvc cisterns are now available in 5/10 and 3/6 litre models for ₹570 to ₹670; a branded cistern costs ₹800 upwards. Government offices are increasingly buying dual flush cisterns, said Jain. Other products like sensor taps and waterless urinals are not very popular because they are costly, he said.

The Municipal Corporation of Delhi is still debating the viability of the waterless urinals it has installed at several locations in the city (see: 'Break the odour', March 21, 2010).

Builders not keen

Rating water fixtures for water efficiency could be the most effective way to promote them among the average Indian consumer, said Aruna Grover, professor at the School of Planning and Architecture in Delhi. She said the majority of builders and architects do not promote water-efficient fixtures. This is evident from the fact that just 117 buildings in India have been certified green under the voluntary LEED-India rating programme, promoted by the Indian Green Building Council, an industry initiative. The majority of the new office and commercial buildings and residential estates do not apply for green rating.

"Declining availability of water may lead to an attitudinal change," said Grover. Rating systems are enforced in several countries. For instance, Australia's Water Efficiency Labelling and Standards system aims to save about 100,000 million litres annually and the WaterSense programme in the US helped save 136,274 million litres water in 2009.

In India, the Bureau of Indian Standards (BIS) has set standards only for manufacturing processes and product quality, not for water efficiency. What's more, these standards are voluntary. Manufacturers claimed they conduct durability and efficiency tests on their own. For instance, Hindware says each of its toilet models are put through seven tests to check flushing performance. The company refused to say more about its testing facilities.

Head of BIS's civil engineering department, A K Saini, said it may not be possible to replicate water-efficiency standards in India. He said water-efficient fixtures should have complementary sewerage system, which can maintain pressure and flow even with reduced water usage.

Standards bureau has norms only for product quality and manufacturing processes

Vijayaraghavan Chariar, professor at IIT-Delhi, contradicted Saini. "The Indian sewerage system is usually designed as a combined system which carries water from toilets, bathrooms and kitchens, leading to excess flow of wastewater. Therefore, installation of water efficient fixtures would not affect flow," he said. The National Building Code also does not provide guidelines or standards for water efficiency.

No agency for water efficiency

The BIS and city civic authorities could take their cue from the Bureau of Energy Efficiency (BEE), under the Union Ministry for Power, which mandates star labelling for several electrical appliances. A bureau official said many factors worked in favour of star rating in the energy sector like rational electricity pricing, an energy conservation act and a dedicated monitoring agency.

The price of water is too low for people to care about its conservation, said Karuna Shree, resident of Delhi and geography lecturer in Delhi University. Mohan of Gurgaon said it is water shortage and not her water bill (of ₹400) that set her thinking about reducing water wastage.

A bureau of water efficiency might help. ■

With inputs from Bharat lal Seth

Water pricing can drive demand

R K SOMANY, chairperson of Hindustan Sanitaryware and Industries Ltd that controls 40 per cent of branded sanitary ware market in India, spoke on promoting water efficiency. Excerpts

On water efficiency standards and checks

There are no standards. The Indian Plumbing Association has compiled a Uniform Plumbing Code which mentions specifications but these have not been adopted by the government. The Indian Green Building Council, too, has specified norms for such fixtures in buildings that can be rated as green. We follow international tests to check efficiency performance of our sanitaryware and fixtures.

On key problems in implementing rating system for water fixtures

The prices paid by consumers for potable water in India are not determined by economics but politics. The moment water tariff is determined by cost of treatment and maintenance of the supply systems, people will start saving water.

On what needs to be done

Introduce a law that makes use of water efficient fixtures mandatory. Building approval authorities should insist on such fixtures while approving building plans and issuing completion certificates. Professional bodies like Architects Association of India should push for water-efficient fixtures. Besides, government should conduct awareness programmes.

How to save 415 litres of water in a day

Most sanitary ware outlets stock water-efficient fixtures

Fixture	Water use in standard fixtures	Water-efficient fixture	Water saved
Toilets	Single flush toilet uses 10-13 litres/ flush	Dual flush toilet in 3/6 and 2/4 litre models	4-11 litres/ flush
Urinals	4 liters; 10-13 litres if toilet pan is used	Sensor operated adjustable flush	2.2 – 10 litres per flush
Taps	10-18 litres/minute depending on pressure	Sensor taps	5.5- 15.5 litres/ minute
Showers	10-25 litres/minute	Flow restrictors	4-20 litres/minute

Source: Parryware Roca and others

Growth thirsty

Groundwater level is plunging in Dhaka. Experts call for making rainwater harvesting mandatory

SUSHMITA SENGUPTA *Dhaka*

Call it the fallout of rapid urbanisation or plain negligence of the authorities, groundwater in Dhaka is sinking at an alarming rate.

According to a study by the Institute of Water Modelling in Dhaka in 2009, groundwater in the city is going down three metres every year. It has sunk by 50 metres in the past four decades and is at over 60 metres below the ground. Officials at the Dhaka Water Supply and Sewerage Authority said the city faces a demand-supply gap of 500 million litres a day. This means one-third of the city's population does not get adequate water supply every day. Last summer the government had to deploy troops to manage water distribution in Dhaka.

A group of architects, engineers and urban planners of the city recently held a seminar with participation of government officials. The government must include rainwater harvesting in building bylaws to save Dhaka, the seminar organised by the Institute of Engineers, Bangladesh, and international non-profit WaterAid concluded.

The present building bylaws of Dhaka, which came into force in 2008, are not enough to ensure natural recharge of groundwater. They suggest 40-50 per cent of building premises should remain unpaved and half the unpaved area should be under green cover to allow natural recharge of aquifers—groundwater meets over 80 per cent of the city's water supply. This is not possible, said Mustapha Khalid Palash, an architect who was the main speaker at the seminar. Almost 65 per cent of the city is paved. The remaining area does not ensure natural recharge of aquifers because top soil at most places is clayey. The authorities must take up rainwater harvesting on war footing to ease water crisis in the fast-growing, densely populated city, Palash added.

The situation was not so bad until three decades ago when Bangladesh had just attained independence. With sudden influx of people the capital city began to expand. Low-lying marshland was filled with earth and swallowed by the city. Development took place around the region's longest water channels, Banani and Gulshan. As the population increased—it has grown 13 times since 1963—developers and the government targeted the channels.

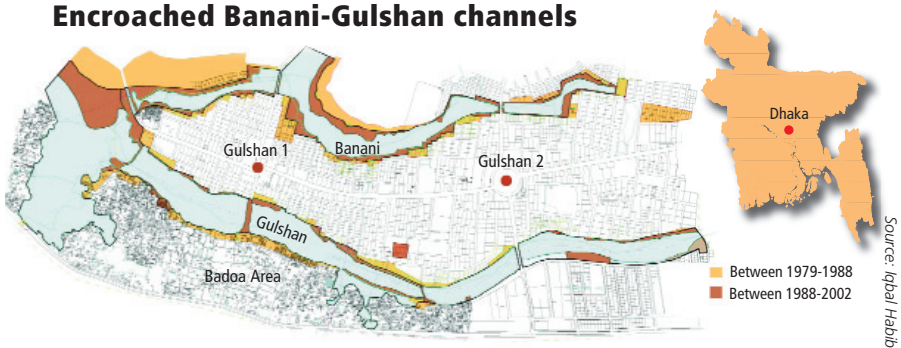
The city authorities converted parts of the Banani-Gulshan wetland into roads and sold the rest to developers and industrialists. Over the years they expanded their territories by filling up the channels. By the time the Wetland Protection Act came into force in 2000, residential buildings, industrial units and numerous slums and squatters had constricted the channels and fragmented them into lakes, said Iqbal Habib, architect and activist of Bangladesh Poribesh Andolon, a green group. The law did not abate encroachment.

In 2006, BELA (Bangladesh Environmental Lawyers Association) filed a petition in the Dhaka High Court to save Gulshan Lake. The court asked the city authorities to prohibit filling the lake. But encroachment continued. In 2009 BELA again approached the court and demanded demarcation of waterbodies. "Despite the court order the authorities have not demarcated the spread of the lakes," said Syeda Rizwana Hasan, activist and member of BELA.

Demarcation of the lakes would help remove encroachments and revive them, Habib said. The lakes are not only groundwater recharge points, they act as sponge in case of flooding, he added.

Removing years of encroachments is not an easy task. Palash said mandating rainwater harvesting would at least help arrest groundwater level, for now. ■

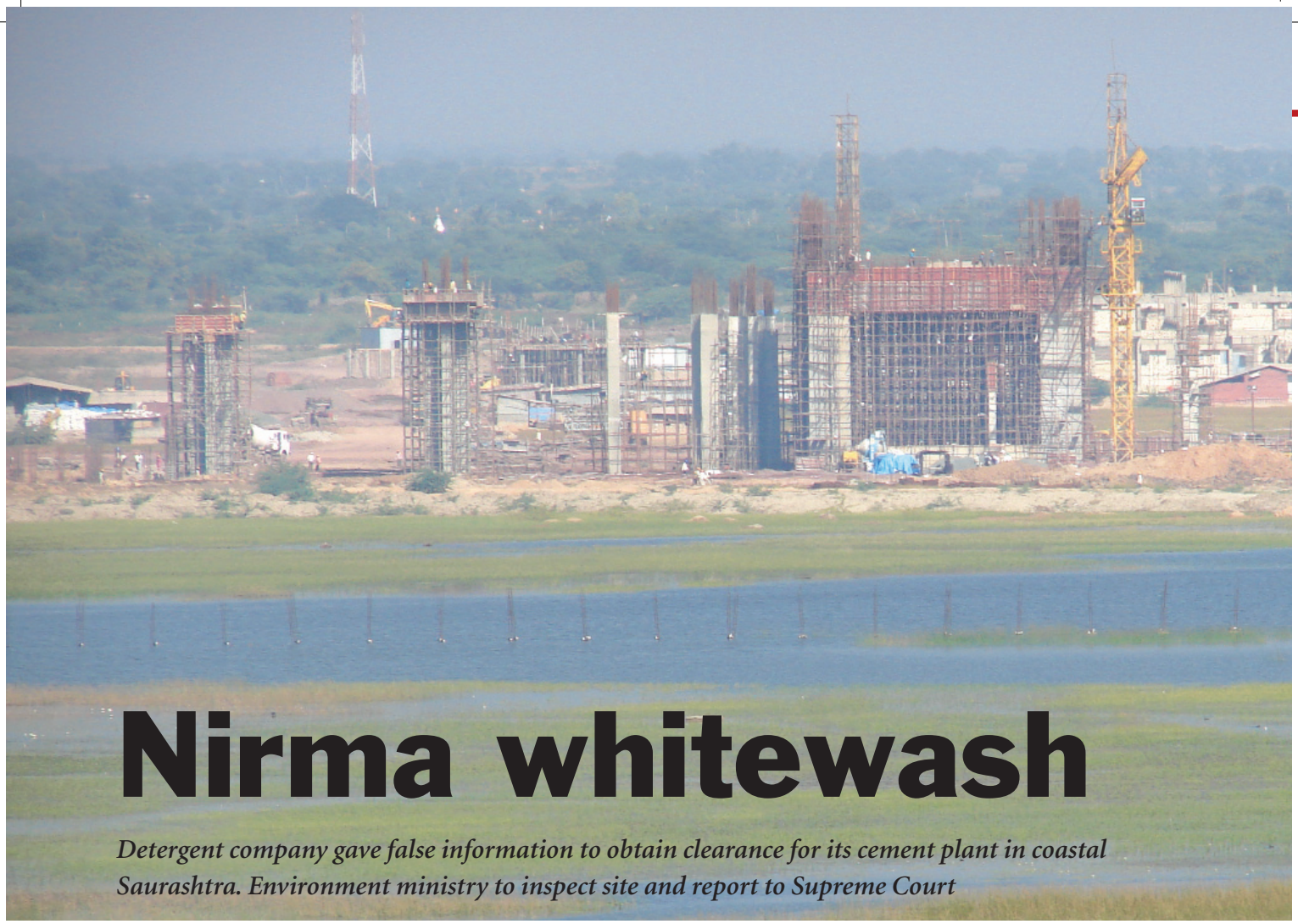
Encroached Banani-Gulshan channels



Source: Iqbal Habib

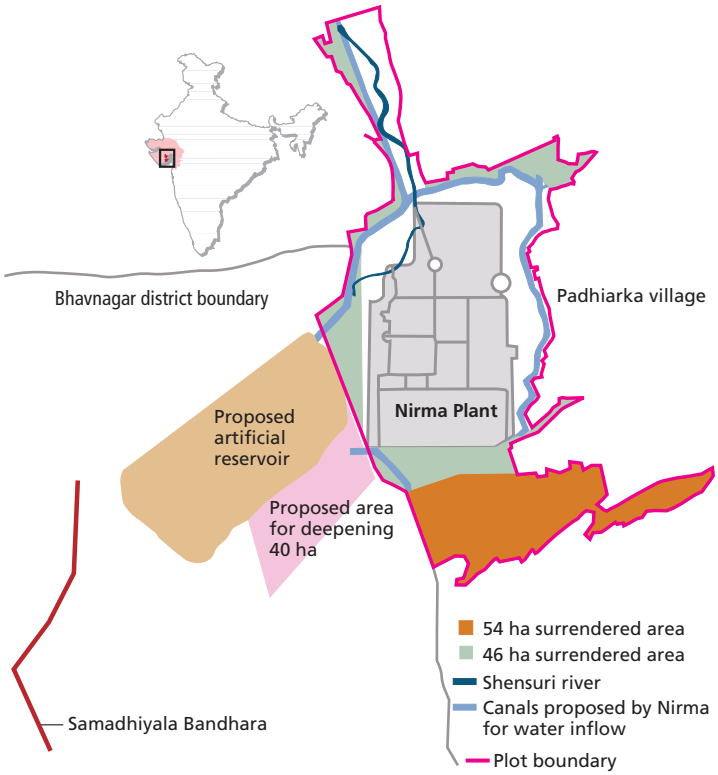
Developers fill up Gulshan Lake and then sell it off as real estate

ADITYA BATRA / CSE



Nirma whitewash

Detergent company gave false information to obtain clearance for its cement plant in coastal Saurashtra. Environment ministry to inspect site and report to Supreme Court



Map not to scale

SUGANDH JUNEJA *Bhavnagar, Gujarat*

About a decade ago, farmers of 15 villages in Mahuva block in coastal Saurashtra could barely grow one crop a year. This was because the groundwater they used for irrigation was saline. Their fortunes changed in 2000 when the Gujarat government created a reservoir—Samadhiyala *bandhara*—by building a dam at the mouth of the river Shensuri that flows through Mahuva. The dam prevented sea water from entering the river. The reservoir's sweet water helped farmers grow up to three crops a year and set up agro-processing units. But the good times were not to last. In 2008, the state government allotted part of the reservoir and its catchment area, totalling 268 hectares (ha), to detergent company Nirma to set up a cement plant.

The cement plant of 1.91 million tonnes per annum capacity, with its 50 MW captive power plant and a coke oven plant, is being built speedily in spite of stiff opposition by area residents. Nirma has also obtained in-prin-

PHOTOGRAPHS: SUGANDH JUNEJA / CSE

Satellite images from ISRO (R) helped prove the plant (L) is in the reservoir

ciple approval from the state to mine limestone from 3,460 ha in Mahuva's Padhiarka village to feed the cement plant. A visit to the site in Bhavnagar district revealed the company has raised a road embankment in front of the plant which is blocking the reservoir water from entering adjacent farms.

"We have complained to the collector and are awaiting his decision. If the water flow is not restored, the farmers will remove the barrier themselves," said Kanubhai Kalsaria, BJP MLA from Mahuva, who has been leading the fight against Nirma and the state's BJP government.

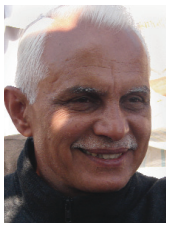
Samadhiyala and three other reservoirs along the coast—Kalsar, Nikol and Malan—are the lifeline of farmers. Government records show the reservoirs, connected by a 40 km channel, irrigate over 8,500 ha agricultural land. But while obtaining clearance from the Union environment ministry, the cement plant site was mentioned as barren land. The reservoir's status has been central to the conflict between Nirma and the area residents.

The matter was first raised in September 2008 during the mandatory public hearing that precedes environmental clearance by the environment ministry. The ministry's record shows only 60 people attended the hearing; residents say close to 400 people were present. Thirteen people objected to the plant's construction in the water body, but the ministry granted clearance based on a rapid environmental impact assessment (EIA) that described the site as barren land.

Reservoir or barren land?

People then formed a front, the Mahuva Bandhara Khetiwadi Paryavaran Bachav Samiti, and moved the Gujarat High Court in March 2009. Their petition challenged the land allotment to Nirma and the validity of the environmental clearance.

The court case and growing public protests forced the Gujarat government to set up a high-level committee to examine the matter. Work at the site was suspended for six months. The panel headed by S K Shelat, adviser to chief minister Narendra Modi, accepted the existence of the reservoir in its report submitted in early August 2009. Of the allotted 268 ha, 222 ha was given to the salinity control division in the year 2000 for building the Samadhiyala *bandhara*, the panel said, adding 100 ha allotted to Nirma was permanently submerged while the remaining 122 ha was in the catchment area that gets flooded during monsoon. The report noted that the land use was never changed in the revenue records which categorised the site as wasteland.

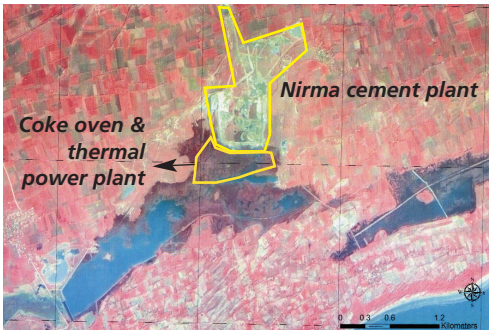


"The road embankment in front of the plant is blocking the reservoir water from reaching the farms. If the authorities do not restore the water flow, the farmers will remove the barrier"

—Kanubhai Kalsaria,
BJP MLA from Mahuva

Satellite map, October 2006

Satellite map, October, November 2006



Map not to scale

The Shelat committee suggested three alternatives. One, allow Nirma to construct the plant in the 268 ha that was allotted. Two, allow construction on 214 ha and return 54 ha to the reservoir. (The committee said this option would not improve farmers' access to the water body because it would be surrounded by the plant complex on three sides and limestone mines on the fourth). Three, allow the cement plant on 168 ha and return 100 ha to the reservoir; the panel did not specify which portion should be returned. The panel said the third option would quieten protesters and improve Nirma's chances of acquiring land for mining from farmers.

These recommendations were reviewed by a sub-committee of ministers, constituted in late August 2009. It chose the second option and directed Nirma to return 54 ha of the allotted land and asked it to increase the water storage capacity of the reservoir by 21.2 million cubic feet (MCF) to compensate for the loss to the reservoir. For this, Nirma was asked to deepen 40 ha of the peripheral area of the reservoir. The present capacity of the *bandhara* is 62.31 MCF. The high court accepted the sub-committee's recommendation to return the 54 ha, in an interim order in

December 2009. The petitioners, meanwhile, obtained satellite images from the Indian Space Research Organisation at Hyderabad to prove the existence of the reservoir. These images were presented in the high court in March 2010 and the court ordered a stay on the construction of the plant till a decision was taken.

In its final order in April 2010, the high court ordered the company to give another 46 ha of land back to the state government in addition to the 54 ha (see 'Court cements Nirma claim', *Down To Earth*, October 31, 2010).

Returning 100 ha to the state entailed a change in the layout and design of the plant. Nirma ought to have informed the ministry about it, as specified in the conditions for environmental clearance, but it did not do so. This is another reason the environmental clearance should be scrapped, the people's front said. Kalsaria said the high court order was not acceptable as the plant was still on reservoir land. "The 100 ha returned is not the land which is permanently submerged. So, what is the point of this alternative?" he asked.

Apex court takes notice

The Samiti then decided to appeal to the Supreme Court where the case is pending. "It was in the apex court that Nirma for the first time conceded that the plant is in the water body," said Anand Yagnik, counsel for the petitioner. A 2002 judgement of the Gujarat High Court had ordered the state government to identify and notify all water bodies and ensure they are not put to any other use. Yagnik said the "judgement has not been dealt with in the manner required, which was why so many water bodies like Samadhiyala *bandhara* remain non-notified."

The apex court asked the environment ministry for its opinion on constructing the plant in a water body and the impact it will have on the reservoir. The ministry sought time to file a reply and said it plans to send an expert committee to the site. The affidavit is likely to be filed later this month.

Faulty EIA

An analysis of the project's EIA report by Delhi non-profit Centre for Science and Environment shows the report did not study the project's hydrological impact. The EIA is silent on the presence of the reservoir as well as the river Shensuri. Only in a table on land use pattern, based on satellite images, the EIA said that 27 per cent of the study area is a water body.

The EIA was conducted in the dry months between March and May which could be an attempt to hide the presence of the water body. Even the Form 1 submitted by Nirma to obtain the terms of reference for the EIA hid or falsified information (see 'Nirma said site is barren' on *p*31), which means the process of obtaining environmental clearance was based on false data.

Farmers say the plant and limestone mines will ruin agriculture

CHRONOLOGY

- **September 2008:** People register protest against allotting water body for Nirma's cement plant at the public hearing
- **December 2008:** Union environment ministry grants environmental clearance on the basis of rapid EIA report, which describes the project site as wasteland
- **March 2009:** People's front moves Gujarat High Court
- **August 2009:** S K Shelat committee, set up to look into people's demands, submits its report giving three options
- **August 2009:** A ministerial subcommittee reviews Shelat panel report and recommends that project should be allowed and directs Nirma to return 54 ha and increase reservoir's capacity to offset loss to the reservoir
- **December 2009:** In an interim order, high court accepts sub-committee's decision and asks Nirma to return 54 ha
- **March 2010:** High court stays construction after petitioners submit satellite images of reservoir
- **April 2010:** High court asks Nirma to surrender additional 46 ha
- **May 2010:** Petitioners file appeal in Supreme Court
- **January 2011:** Apex court directs ministry to respond. Ministry seeks time to get site inspected before filing an affidavit by February 14, 2011

Industry eyes village commons

Nirma's case is not an isolated one. In Andhra Pradesh, the state government allotted a portion of a wetland in Sompeta *mandal* in Srikakulam district to Nagarjuna Construction Company

Ltd. The proposed 2,640 MW coal-fired thermal power plant on *beela* (wetland) triggered public protests. Two persons were killed when police opened fire on protesters on July 14, 2010. The next day the National Environment Appellate Authority cancelled the project on an appeal by an NGO, Paryavaran Parirakshan Sangam, working in the area. The cancellation followed a site inspection report submitted by a committee of the Union environment ministry. The ministry's panel established the presence of the wetland and said the thermal plant would affect fishermen and farmers in 30 villages in the district. These villages depend on the *beela* for irrigation and inland fishing.

Nagarjuna Construction Company had not disclosed the presence of the water body at the project site at the time of obtaining environmental clearance. The EIA was carried out in the dry months and the project land was shown as wasteland. "The clearance to the power project in Sompeta was cancelled because the ministry failed to appreciate the real nature of the land and the EIA did not mention it either," said Ritwick Dutta, counsel for petitioner.

The common link between the Sompeta thermal power project and Nirma's cement plant is that in both cases the EIA report suppressed and misrepresented facts. The two EIAs did not disclose the crucial information that the project sites are in water bodies. The question then is whether a water body ceases to exist merely because it has not been notified. "In Sompeta, the wetland was classified as *tampara* in the revenue records which means wasteland. The site visit revealed that the wasteland is indeed a seasonal wetland," said Dutta.

An EIA consultant based in Delhi said government records only provide additional reference. "The most important aspect is the site visit report. So, the EIA should have reported a water body or wetland if one exists at the site even if the revenue records call it grazing or waste land," the consultant said.

Not including correct site-specific information can lead to cancellation of clearances, he added.

In practice what is happening is that government agencies are taking advantage of unchanged land use of water bodies and wetlands to allot them to industries. Non-notified water bodies, usually categorised as waste or grazing land, are the easiest to divert for industrial use (see box 'Common assets given for exclusive use').

Common assets given for exclusive use

To acquire village common land, the Gujarat authorities need to take consent of the gram panchayat under Section 96(4) of the state Gram Panchayat Act of 1961. For this they have to first issue a notice to the villagers. A Supreme Court judgement of 1996, however, ruled that for transferring village common grazing or wasteland, no intimation to the villagers is required if the gram panchayat gives its consent. This judgement has been increasingly cited and used to acquire the village common land for industry. Getting the support from the gram panchayats is easy for the industry that uses money or force, sometimes both. Thus the land which really belongs to the villagers is increasingly being diverted for industrial use.

What's more worrying is that many traditional water harvesting structures like ponds, lakes and tanks are located on common land. These are a source of potable water, irrigation and other uses to the villages. So, when the government diverts such common land it is ceding a common resource for industrial use.

Nirma said site is barren

Parameter in Form I	Nirma's Response	CSE analysis
Creation of new land use (1.3)	Industry will be set up in barren land	No information is given on the presence of a large water body
Earthwork required for the site, including fill or excavation (1.8)	Complete plant set up with necessary infrastructure will be constructed	No information is provided about filling and bunding that is currently being done to keep the water at bay
Impoundments, damming or culverting, realignment of other changes to the hydrology of the water sources or aquifer (1.21)	Existing rainwater drain will be extended and diverted to the sea	This is clear suppression of information as the plant is located inside a water body. There is evidence of two check-dams created by the company to stop the flow of water as well as the destruction of check-dams that existed

Mahuva claims get boost

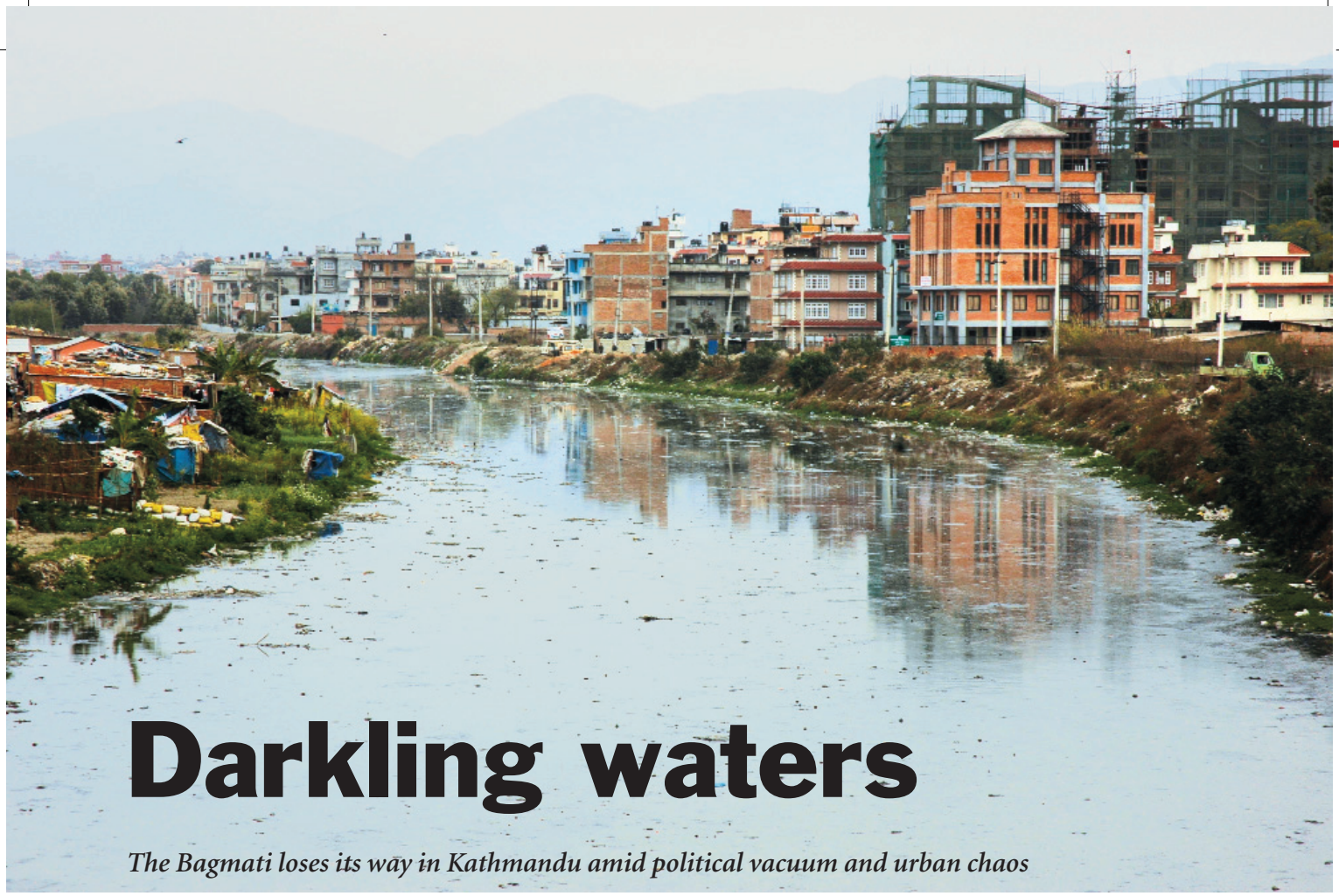
The environment tribunal's ruling scrapping the Sompeta power plant is a shot in the arm for Mahuva residents. A January 31, 2011, judgement of the Supreme Court also rules in favour of community rights over natural resources. The judgement was passed on an appeal against the decision of a division bench of the Punjab and Haryana High Court. In Patiala district of Punjab, two persons illegally filled up a village pond to build houses. The revenue records mentioned the site as *gair mumkin toba* or village pond, belonging to the gram panchayat. The apex court judgement upheld the high court order to evict the occupants (see 'Return of village land' *p*11). While doing so, it noted how water bodies are being given away to industries by authorities colluding with them. The court has asked all state governments to prepare schemes for evicting illegal occupants of village commons and return them for community use.

The Supreme Court order to protect village common land and water bodies strengthens the plea of the farmers of Mahuva that their rights over water body cannot be alienated, said Yagnik.

Nirma had suggested to the court that it will build an artificial water body to compensate for the loss of the *bandhara*. The new water body will be fed by three canals (see map on *p*28) to keep water inflow intact. This study was done by a private consultant hired by Nirma.

The Gujarat government agreed to the alternative after Water and Power Consultancy Services, an agency under the Union Ministry of Water Resources, said it is technically feasible.

Nirma spokesperson Ashish Desai refused to comment on the case saying the matter is *sub judice*. ■



Darkling waters

The Bagmati loses its way in Kathmandu amid political vacuum and urban chaos

ADITYA BATRA *Kathmandu*

In Kathmandu you can smell the Bagmati before you see it; in Sundarijal you can hear this river as it cascades down from its headwaters to nourish the paddy fields in the plains below the Shivapuri hills before it finds its way into the city, much abused and yet revered.

The chaos and urban sprawl of today's Kathmandu have taken a serious toll on the stretch of the Bagmati and its tributaries that meet in the city. In the absence of clear guidelines regulating river water use and diversion, the city extracts some 30 million litres of water each day from this seasonal river to quench its thirst, even in the dry season. During the week-long festival of Mahashivratri, which usually falls in February, authorities resort to pumping groundwater to augment the river flow.

Much of the city's garbage—and the city generates about 600 million tonnes daily—is dumped directly in the river. A 2003 study by non-profit Environment and Public Health Organization found that the chemical-oxygen demand (COD) of Bagmati waters was 400 mg/l within the city and immediate downstream areas, 10 times higher than what is considered safe. Biochemical-oxygen demand (BOD) levels were as high as 100 mg/l in the heart of Kathmandu. Another study the same year by the Asian Development Bank and ICIMOD, a leading inter-governmental research body, found that city discharges 21,000 kg of domestic sewage daily into the Bagmati, accounting for 42 per cent of its total BOD load.

In Kathmandu, the Bagmati is a cesspool that has no self-purifying capacity left. Ironic for a river believed to purify the souls of those who bathe in it.

Urban growth pangs

Nepal's urbanisation started only after the fall of the Rana regime in the 1960s, and nowhere was this growth so pronounced as in the Kathmandu valley. According to the 2001 census, 1.65 million people lived in the valley, a figure that will reach 3.4 million by the end of 2016, clocking an annual growth rate of 4.9 per cent; in some fringe areas it is doubling in less than five years.

Unlike the early settlers who preferred lower reaches of the valley, leaving a buffer that separated settlements and the river and its tributaries, the new settlers rapidly encroached the riverbanks. The temples, ghats and cremation grounds were soon interspersed with squatter settlements, buildings and garbage grounds.

Formally established in 1100 AD as a walled city with 33 neighbourhoods laid out in the shape of a sword, Kathmandu once had a planned waste management system. Open defecation with clearly earmarked zones along small ponds was the norm from which wastewater was recycled back to the fields, says Padma Sunder Joshi, who is with UN Habitat and has studied the river's history. This was done to avoid polluting the shallow aquifers feeding the *hiti*s, or the stone water spouts, the main source of drinking water for the valley residents. Waste management practices were intertwined with designated days and festivals. For instance, storm water drains and open wells were cleaned on Sithi Nakha, the driest day in the driest month of May. The festival of Pichash Chaturdashi was dedicated for people to clean their courtyards.

Constricted by squatter colonies

Some 24 of the 40 squatter settlements in Kathmandu are on the banks of the Bagmati and its tributaries, as per a study by Lumanti, a non-profit working with the urban poor on housing rights.

It found 60 per cent of the squatter households pollute the river, by defecating on its banks or draining their sewage into it. Even settlements away from the river use the nearest storm water drain to dispose of their waste, which eventually finds its way to the river.

Lajana Manandhar, who heads Lumanti, resists allegation that squatters must be relocated to save the river. "Who is a squatter?" she asks. The government is sticking to 48-year-old survey maps. This is unrealistic because the river course has changed since, she says.

Rather than displacing people, Manandhar suggests establishing on-site waste disposal and treatment system, just like the one in Narayan Tole squatter settlement. Toilets in this community are connected to the system that uses a septic tank and a bio-filter. People are trained to locally manage the system.

Land encroachment is particularly acute along the Bagmati as the river frequently changes its course, creating new landlords and new encroachers. As per Nepal's Lands Act of 2021 (2021 Bikram Sambat is 1964 as per the Gregorian calander) if the river changes its course, the legal title to the river land goes to the government. But in most places, the government does not physically possess such land; they are in private hands or encroached upon, says Bhushan Shrestha, a GIS expert who has prepared maps for various committees working to revive the river. A lot of river land was grabbed when the government changed its reference cadastral maps from 2021 BS to 2044 BS (1964 to 1987 AD). "You can still recover the land from squatters, but private encroachers with land deeds are the real problem," Shrestha adds.

Public outrage

Over the past three decades, public outrage over the state of the river has snowballed. Activists like Hutaram Baidya, who sees the civilizational loss in the degradation of the Bagmati (see 'A civilisational loss', *Down To Earth*, August 16-31, 2011), to non-profits like Friends of the Bagmati have been championing its revival. Some have even resorted to public sentiment—in 1997, a group of 50 signed a declaration on the river's ghats, asking for not immersing their cremated remains in the Bagmati.

The Nepal River Conservation Trust, started by a group of river travel guides, organises a two-and-a-half-month Bagmati River Festival each year, starting with Earth day on June 5, where they undertake river clean-up drives, plantation, heritage walks, films and art shows, cycle rallies and rafting trips to raise awareness.

Lawyers are also doing their bit to force the government to act. Prakash Mani Sharma, a lawyer with Pro Public, an environmental law non-profit, has fought many legal battles on behalf of the Bagmati. Many of Sharma's cases against the city administration are to do with illegal dumping of solid waste along the riverside. "In Kathmandu, municipal waste and medical waste are dumped together; it is a public health hazard," he says. In 2002, Nepal's supreme court had ordered the city authorities not to dump waste on the river banks without an environmental impact assessment. When Sharma found municipalities were openly disobeying the order, he filed a contempt of court case. The court cracked down hard. Seven secretaries from different ministries, including environment, physical planning, local development and the prime minister's office (PMO), were ordered to personally attend the Court's hearings. The court constituted a committee under the chairmanship of secretary of PMO to ensure that its orders are followed in letter and spirit.

Even so, there has been no let up in garbage dumping on the river banks.

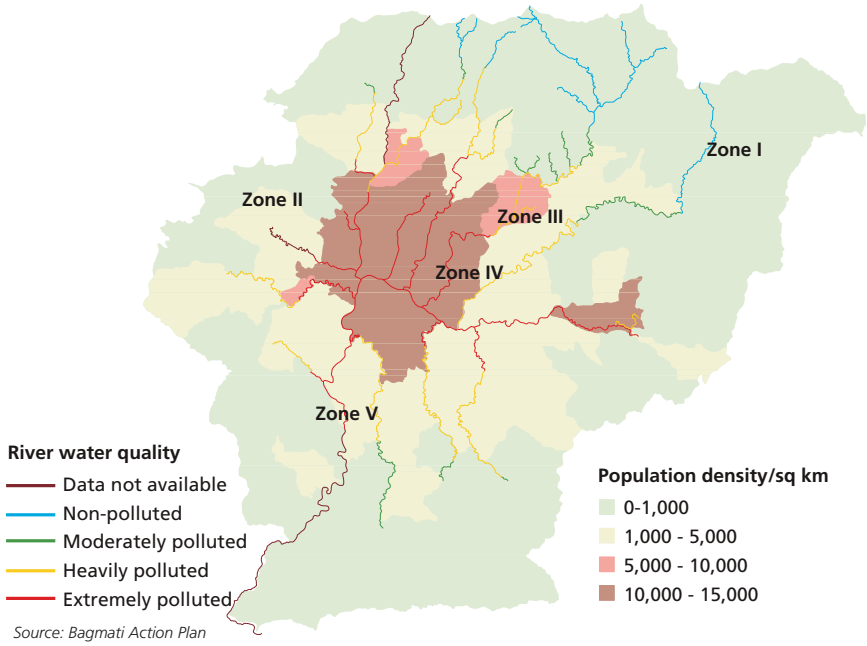
High powered intervention

With growing pressure from the civil society, the government in 1995 constituted a High Powered Committee for Implementation and Monitoring of the Bagmati Area Sewerage Construction/ Rehabilitation Project. It was later renamed High Powered Committee for Integrated Development of the Bagmati Civilization, and its scope was expanded to cover the entire valley.

Committee members admit that progress on rehabilitating the river has been slow. So far, it has constructed river training walls on some stretches upstream to contain the fickle river in its original course, and is laying sewer lines and conserving wetlands in the catchment area. Its main achievement is maintaining a 16.4 mld (million litres a day) sewage treatment plant (STP) at Guheshwori, a few hundred metres upstream of the Pashupatinath temple. Of the five STPs in the valley, Guheshwori STP is the only one that functions, though partially. The other STPs, belonging to the activated sludge family and located at Dhobighat, Sallaghari, Hanumante and Kadu, have been abandoned, their oxidation ponds now converted to playfields where children play football.

The committee has built interceptor drains along 22 km of the Bagmati to collect and divert sewage to Guheshwori

Kathmandu: feeding off its rivers



Source: Bagmati Action Plan

PHOTOGRAPHS: ADITYA BATRA / CSE

Students take to the streets during the popular Bagmati River Festival

STP. It has dug a tunnel below the temple that empties treated wastewater at Aryaghat, downstream of the temple.

The 572-metre tunnel was built after the priests of the Pashupatinath temple bitterly opposed the plan to let the treated wastewater flow through the temple complex. "They said the treated wastewater of the Bagmati may be clean, but not pure," recalls Bhushan Tuladhar, an environment researcher. "Maybe it was a smart decision, as the Bagmati today has less, but cleaner water flowing across the complex," he adds. On most days, sewage is bypassed, or released directly into the river.

Frequent power outages are the reason the "state-of-the-art" Guheshwori STP functions below its capacity, says Ram Chandra Devkota of the committee. The extended aeration system of the STP needs 24-hour electricity supply, a tall order in a city used to 16 hours of load shedding in the dry season, he says, adding "whatever we have done till now is far behind the demand or necessity."

The problem is that it is difficult to estimate the total sewage generated, when close to 60 per cent of the city's drinking water is sourced from groundwater. As groundwater is unregulated, no one can accurately estimate the amount of wastewater the city generates each day. So STPs are designed with only ballpark figures, not hard data; sewage is estimated on a per capita basis.

Besides, septic tanks are the norm in this city. In the absence of a master plan and due to funds crunch, sewerage coverage has expanded haphazardly. In many parts of the city, residents have, on their own, connected their domestic sewage hume pipes to the city's sewerage network; leakages are common. Over decades, dozens of plans for sewerage coverage were prepared; none were implemented in full.

Needed: integrated approach

The latest attempt to heal the Bagmati, from its origins in the Shivapuri hills to Chouva where it leaves the valley, was launched in 2008. The committee and the National Trust for Nature Conservation, an autonomous body, have put together the Bagmati Action Plan. Based on its water quality and settlement patterns, the plan, applicable from 2009-2014 with a budget of close to 15 billion Nepalese rupees, divides the valley into five zones and suggests different measures for each zone. This includes protecting the catchment area and checking illegal sand mining in the upstream zones one and two; building decentralised wastewater treatment systems in peri-urban areas in zones two and three (see map on p23).

The plan's main target is the densely populated and polluted urban zone four comprising eight municipalities. It recommends setting up several mechanical STPs, and other measures to deal with untreated sewage, solid waste and industrial effluents. It identifies the vexed questions of illegal encroachments, rampant construction along the river banks as well as the erosion of aesthetic, cultural and architectural values. Zone five, an agricultural area in the lower reaches, would not need much intervention if the suggested measures are taken in upstream zones, the plan says.

As of now, it is only an inventory of activities, says Shrestha who led the GIS mapping in the plan document. Each suggestion will have to be subjected to detailed engineering studies to make this operational, he adds.

In Kathmandu, municipal and medical wastes are dumped on river bank. It is a public health hazard

Chaos amid political vacuum

Each of the eight municipalities in the valley has its own authority and working plans. But there is no integrated land use plan for the valley, although they all share a river. "This is the main impediment to our work," says Devkota. "A lower riparian municipality cannot easily enforce or ban activities in the upper reaches of the river; locals will protest."

This is exacerbated with the political chaos in the country. With no local elections held in over 10 years, there are no elected officials handling municipal affairs in Nepal; all urban areas are run by executive officers nominated by the government. With no elected local body to talk to, the committee deals directly with people for land acquisition, laying sewer lines, or paying compensation for loss of standing crops. "We form community-level concern groups, ensuring representation from all political parties active in that area to reach consensus," Devkota says.

Though formed by the order of the cabinet, the committee has no real authority. A bill was tabled in Parliament last year to give it the legal teeth but it is gathering dust amid political instability. Some in the committee were relieved by being hauled up by the court in a case filed by Pro Public, as the court's orders would give them the legal teeth to remove encroachers.

"This city has too many masters," says Dipak Gyawali, a noted water researcher, referring to the many master plans created over the decades. He says many details of how to revive the river should be left to stakeholders to work out among themselves. Instead of relying solely on civil engineering-dominated plans, he says the government should coopt the religious trusts and 136 *tirtha*s (sites of pilgrimage) that control the temple lands along the river banks into this initiative. If it is to flow clean and pure again, the Bagmati must top Nepal's social and political agenda. ■

Channels of change

Two villages in Uttar Pradesh have reversed the trend of migration by digging six kilometres of channels to bring water to drought-hit farms

RICHARD MAHAPATRA *Lalitpur*

Call it the fallout of seven years of severe drought or government inaction, a silent revolution is brewing in Lalitpur district of Uttar Pradesh. Communities are getting united and digging channels to bring water from government canals to their fields. Some are volunteering labour, while those belonging to Scheduled castes and tribes are using the government's employment guarantee scheme to link their farms to the canals.

Their efforts are beginning to pay dividends. As one travels through Lalitpur, Tindra and Budwani villages present a sharp contrast to the situation prevailing in the district. Despite a prolonged dry spell, residents are harvesting two to three crops a year. And those who had migrated are returning home.

The ball was set rolling at a funeral meeting in Tindra in April 2007.

Facing a severe drought since 2003, farmlands in the village looked like a moonscape. Deficit monsoon—40 to 50 per cent—ensured farming only in one-tenth of the 140 hectares (ha) farmland. All but six of the 56 families in the village had migrated in search of living.

"A few of them would visit the village only in case of a death," said Uttam Singh, who works on livelihood issues with Parmarth, a non-profit in Uttar Pradesh. He visited the village for three years to initiate drought-proofing measures. "I could hardly find anybody," he recalled. So he took the funeral meeting as an opportunity and talked to the gathering about a new life for their village.

"We had to choose between this opportunity and the life as migrant labourers," said Srinam Sahariya, who came to the village after almost a year to participate in the funeral meeting. Sahariya and a few other migrants agreed to stay back. Subsequent meetings saw the birth of a village association, Gram Chetna Samiti. And its first decision was to get water to the village.

PHOTOGRAPHS: VAIBHAV RAGHUNANDAN / CSE

Farmers in Tindra now grow wheat and vegetables that need regular watering

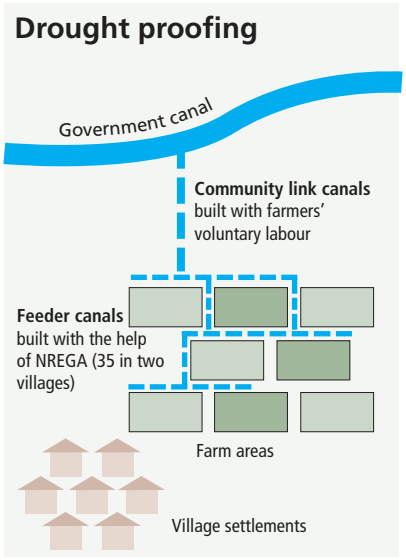
It was a tough challenge

All dug wells, dried since 2003, had silted up as people had abandoned them. The only option was to link the village with a nearby government irrigation canal. Though not perennial, it releases water four times a year for irrigation of kharif (summer) and rabi (winter) crops.

But diverting its water was illegal. Moreover, the link canal had to be dug through a patch of forest, which, a forest official had warned, required permission from the Central government.

"We decided to go ahead without any permission," said Ramesh Pardes, another migrant from the village.

But several others cited loss of income as a pressing reason for not stay-



ing back in the village. At this point Parmarth activists promised them to facilitate works like road construction in the village under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA). These works ensured them a daily wage of ₹100 and revitalised their spirit.

Sixty people worked nonstop for 60 days to dig the 2.37 km link canal, which is two feet (about 60 cm) deep and three feet wide. "Our family members took turns to work," said Barelal Sahariya, a resident. In June 2007, the villagers saw water gushing right in their backyard. "The next rabi season, for the first time in my life, I grew two crops. This included wheat, which we had thought would never grow in our village," said Srinam Sahariya.

In the past two years the link canal has ensured farming in 35 ha. "Twenty families now grow two crops a year, while 10 others grow three crops, including vegetables," said Pardes.

An estimate by residents shows their average annual income has doubled in the past two years. "Nobody has migrated this year despite the lingering drought," said Singh with a smile.

Farmers used employment guarantee scheme to bring water to their farms

Budwani's canal sarpanch

Water politics dominated caste politics in panchayat polls

Though from a Scheduled Caste, Sharman Banskar won the panchayat polls in November 2010 from Budwani, a higher caste-dominated village. All he spent for the campaign was ₹2,000. This includes ₹1,000 spent on sweets to celebrate his victory. Residents said it is the community canal that gave Banskar such unprecedented victory. Electing him was a strategic decision for the village. The gram sabha now has a willing head to bring in maximum development money to the village. "My first job is to make sure that the people's canal reaches everybody. I am preparing a water security plan for the village," said Banskar. He also wants to rope in neighbouring villages in digging more canals. But there is a nagging problem, he said, "Government hardly says yes to village's own plans."

Average annual income of Tindra residents has doubled in the past two years, shows an estimate

The spinoff

The news of Tindra residents growing two crops a year spread like wildfire in the drought-hit Lalitpur district.

In the neighbouring Budwani village, Sahrman Banskar floated the idea of digging a government-proposed canal by themselves. "The government had proposed a link canal to the village some 40 years ago. The proposal never saw the light of the day but we have been paying an irrigation tax of ₹125 per acre (0.4 ha) since then," said Hanumath Singh, a 60-year-old resident.

Banskar also prposed to stop paying the irrigation tax. Everybody agreed. "Water scarcity had turned our farms into wastelands. The new generation hardly ever cultivated the farms because of poor availability of water," said Banskar. He has been elected as the sarpanch in the recent panchayat polls (see 'Budwani's canal sarpanch').

More than 100 people from the village worked for 44 days to dig a 3.4 km link canal from a nearby government canal. The link canal now irrigates 445 ha in Budwani. Most residents are growing three crops a year, including vegetables. According to the agriculture department's records, the village had such sowing coverage in the early 1970s. Estimates by Parmarth show that the village would earn ₹1.36 crore from agriculture in 2010-11. This is almost five times what the villagers earned from agriculture in 2002.

"The jump is natural. Earlier, we could cultivate just 10 per cent of our land and that also to grow a single crop," said Rakesh Rajput, a farmer.

The revolution did not stop at the community link canals. They brought water only till the village and several farmers whose farms were far off could not benefit from them.

Encouraged by Parmarth, farmers belonging to Scheduled castes and tribes demanded work on feeder canals and levelling of their unused lands under MGNREGA. Under the law, these farmers can work on their fields to develop it while being paid a daily wage. So far, as many as 35 feeder canals have been dug in both villages to cater to individual fields. Crops now flourish in farms that used to lie fallow.

Going by villagers' accounts, at least 10 villages neighbouring Tindra and Budwani are drawing plans for similar community canals.

However, the threat of community clash hangs over the region as it takes irrigation system into its own hands. The canals will need regular maintenance and a robust water distribution mechanism with rising use. "We are aware of it and planning a village meeting on it," Singh said.

Residents of Tindra and Budwani are getting ready for the next phase of the canal revolution. ■

Bundelkhand's dalit women join hands to drought-proof their villages

Paani panchayat meeting in Kalothara village (photographs by Shehfar)

SHEHFAR

96 women-led pani panchayats take over water resource management

As in the previous years, farmers of the Bundelkhand region of Uttar Pradesh started facing acute water shortage this year, too, with the onset of summer. There were media reports of farmers stealing water to irrigate crops. With scant rains and little help from the government, most people in the region faced a bleak future. But people of three backward districts in the region—Jalaun, Hamirpur and Lalitpur—hope to ease their water woes. They have started work to secure their water resources.

In 2011, women from 60 gram panchayats of the three districts got together to form paani panchayats (water councils) in their villages, which have become a model for local self-governance to address water and employment problems in rural areas.

The focus of these paani panchayats, mostly led by dalit women, is to create more water resources, revive old ones and conserve natural water bodies with the help of traditional and modern technology. "We are planning to revive all old and dried up water structures and construct new ponds with the help of the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) and the panchayat," says Sunita Devi, a paani panchayat member of Jalalpur village in Hamirpur's Sarila block.

The first paani panchayat was formed in 2011 in Jalaun district. By September 2011, a total of 96 such water resource management councils were formed (see 'District wise break up of water management councils'). "The idea of a paani panchyat is to increase women's participation in decision-making, especially on matters related to water and livelihood security in the Bundelkhand region," says Sanjay

District wise break up of water management councils

District	No of Gram Panchayats	No of pani panchayats	No of Jal Saheli	Category wise classification			
				SC	ST	OBC	Gen
Hamirpur	20	26	48	23	0	16	9
Lalitpur	20	40	64	25	4	32	3
Jalaun	20	30	60	45	0	14	1

Singh, secretary of Jalaun based Parmarth Samaj Sevi Sansthan (PSSS). The organisation has been helping set up the paani panchayats with aid from the European Union.

The results are there for all to see. For example, the paani panchayat of Gahuli village, also in Sarila block, has revived its pond, and has framed rules to protect it from contamination. "Earlier, solid and liquid waste of the village was directly dumped into ponds. As a result, hand pumps around it were yielding contaminated water. People fell ill and the water table also declined.

The pond in Gahuli was revived by the village water council and strict rules have been framed for its protection

The paani panchayat took an initiative to clean the pond and made strict rules to protect it (see 'Rules to protect water bodies'). "The groundwater level has increased remarkably. We did not face water shortage this summer, people got water for their daily needs from the handpumps. Health conditions have improved Jamuni Devi, a jal saheli, says there were hardly any incidents of jaundice and diarrhoes in the village this year after the pond was cleaned and revived-because of good water quality and there were hardly any cases of jaundice and diarrhoea," says Jamuni Devi, a water worker of Gahuli.

Stressed by water woes

The paani panchayats offer a way out for women who have to fetch water from a distance. Scarcity of drinking water had been steadily increasing in the region due to scanty rainfall. In the past Bundelkhand practised water harvesting and had tanks and traditional water harvesting structures. However, most of these structures have fallen into disrepair or have completely been destroyed due to apathy of local people and governments in maintaining them. This has directly affected the health of women who have to spend long hours in fetching water over long distances.

"Din bhar ghado - ghado khopdi pe dharo, ladkiya othayi rahi to baal jhadno lagay" (all day, the girls and women of village have to carry pots of water on their heads; as a result, young girls are losing their hair), says Jamuni Devi. Though water is available in the village now, women have to carry water from one end of the village to another, covering a distance of 50 to 400 metres. The paani panchayat has demanded piped

water supply from the water supply department.

The Ministry of Drinking Water and Sanitation, however, claims that these districts have easy access to water. Its data shows 86.46 per cent habitations have been covered by water connection in Lalitpur district. Jalaun and Hamirpur districts have a coverage of 91.19 and 97.10 per cent respectively. Things are different on the ground. Kalothara village of Lalitpur's Tabehat block had four hand pumps, but only one is in working condition; 121 families in the village depend on this single hand pump. The situation is no different in villages in other districts of the region. Usually, after installing a hand pump, the government declares a habitation covered, but it fails to provide water supply to all families, say residents.

"We have to wait for hours to get a pot of water from a hand pump providing potable water. More than 650 people depend on a single hand pump. In summers, we are compelled to use contaminated and saline water as one hand pump is not sufficient meet the demand," says Ramvati Devi of Kalothara. The paani panchayat of the village invited the district magistrate to spend a day in the village. "Forty-five women went to the district magistrate's office and requested her to visit our village and see how difficult it is to spend a day in such conditions. Finally she agreed and declared our village as an 'Ambedkar Village'. But the feudal class families and politicians have created problems in development, now we make a plan to fight against them as well," says Sangeeta Devi, a resident.

Rules to protect Gahuli pond

- **Defecation is strictly prohibited in the surroundings of the pond**
- **Any sort of domestic waste (solid and liquid) discharge in ponds in prohibited**
- **Dumping of plastic, glass items, cloths and dead animals in ponds in banned**
- **Irrigation from ponds is not allowed**

The scarcity of water and restricted options of livelihood (agriculture is totally rainfed) have forced most dalits and tribal families of the region to migrate to cities and small towns. "At least one male member from every dalit family of Jalalpur village has migrated to nearby cities. Every year, many families seasonally migrate to nearby cities because of water scarcity. There are is no option for livelihood during the lean period," says 53 year old Ranjan Dulaiya , a paani panchayat member.

Jalalpur residents hope things will improve. It has more than 40 hand pumps. But the Harijan Basti (dalit neighbourhood) in the village, inhabited by dalits, could not access water from them. A pipeline runs through the village, but it does not reach the basti. When the residents approached the upper-class residents of the locality, they faced resistance. The well in the basti has also dried and the only source of water in summers was the river Betwa; women walked three kilometres to reach it. Every day, the women walked to the river two to three times to collect sufficient water for their families. The paani panchayat of Jalalpur (Harijan Basti) changed their fortune. The women fought for their rights; managed to revive the local pond, and got a hand pump installed. Their lives have changed for the better.

"This (hand pump) is an enormous success for us; our confidence is high," says Gayanishwari Devi. The paani panchayat is taking other decisions, too. We have started to fight for job cards (under MGNREGA) to ensure that every family has one card and 100 days of guaranteed employment as well. We have also discussed with other paani panchayats to take collective initiative to improve education and health facilities,"

With more than 3,000 women members, all the 96 paani panchyats in the three disticts of Jalaun, Lalitpur and Hamirpur are led by 172 jal sahelis (water workers). Their demand is to ensure sustainable development in their villages through self-governance. They are now demanding a place of a sub-committee of gram panchayat. "Slowly but steadily change can be noticed in the region," says Singh of PSSS. ■

Scanty rainfall

Districts	Normal rainfall (mm)	Avg. Rainfall in (2002-2011) (mm)	Water sources affected by the groundwater table depletion (in percentage 2001-2010)
Hamirpur	851	644	93.33
Lalitpur	879	735	50
Jalaun	787	570	75

Source: Report on Drought Mitigation Strategy for Bundelkhand region of UP and MP (unpublished), inter-ministerial Central Team, May 2008, India Meteorological Department (IMD) and question no 2305 answered on 10/03/2011 in Lok Sabha (Indian Parliament)

Source URL:
http://www.downtoearth.org.in/content/bundelkhands-dalit-women-join-hands-drought-proof-their-villages

Fertile rocky land

With help from a non-profit, graziers reinvent a soil conservation practice, turn into thriving farmers

JITENDRA *Karauli, Rajasthan*

Moolchand looks up after piling a stack of his wheat harvest, wipes sweat from his face, and smiles. "Harvests are more compared to last year and I will be busy till the wheat reaches my house," he says. The 63-year-old farmer from Nivera village in Rajasthan's Karauli district points towards a low cement structure across the dried stream Karaiwahada, and says, "this *pagaraa* has changed my life. There was a *kuchcha pagaraa* here 10 years ago but we could harvest only a third of what we do now."

Moolchand then gets busy making a *machaan* (tree-house) where he will stay the night to guard the harvest against wild animals. He has harvested seven tonnes from his 1.2-hectare farm. Asking his son Kuber to look after the grain, Moolchand says, "Earlier, we were completely dependent on cattle rearing. But after a fodder constraint in the early 1990s, we took to farming. The old *kuchcha pagaraa* came to our aid. Even my grandfather had no idea when the stone structure was erected."

About 200 km east of Rajasthan's capital Jaipur, once abounding in prickly acacia and terribly parched in summer, Moolchand's village is a part of a region reinventing an old soil conservation system. The erst-

Moolchand, a grazier-turned-farmer in Nivera village, Rajasthan

PHOTOGRAPHS : JITENDRA / CSE

(Above) Concrete* pagaraa, *a soil conservation structure, built next to* kuchcha pagaraa *in Nivera village; Rock paintings in Albati village show* pagarra-*like structures

while grazier describes the *kuchcha pagaraa* as a low wall of stone plates that check the soil being swept away by the stream's monsoon flow.

Karan Singh, an activist with non-profit Gram Gaurav, explains the structure's working. "The stream carries rainwater and soil from surrounding plateau and hills. The *pagaraa* makes this soil settle down and accumulate on bed-rocks," he describes. People grow crops on this accumulated soil once the monsoon recedes.

The genesis

Singh's organisation is among those credited with giving a new form to these traditional irrigation structures, making them more effective. "In 2001, I initiated construction of lakes and ponds in Sawaimadhopur district, adjoining Karauli. These areas were then reeling from water scarcity. Soon I was looking beyond textbook water harvesting methods," he says.

Some families in Khajura village in Karauli were practising farming by constructing *kuchcha pagaraa*s to slow down soil erosion. This traditional system of farming and water harvesting had a big influence on Singh who was schooled in water conservation by constructing ponds and lakes. "The farmers did not use fertiliser but the water coming down to the stream was replete with organic manure," he says.

Soil was still getting eroded. Singh thought a cement structure would be more effective in checking erosion. "I was, however, an outsider. People in the region were understandably wary of me and not ready to experiment," he recalls. In 2006, two residents of Albati village in Karauli, Ram Singh and Shripath Gurjar, broke the ice and helped Singh organise a meeting with farmers in their village.

Breaking mindsets

At the meeting, a few farmers described the history of *pagaraa* in the region. They talked of a legend, which describes people of the Lodh community practising farming on rocky land using this method 300 to 400 years ago. There are remains of *pagaraa*s in the jungles surrounding the area. Such water harvest-

ing structures can also be seen in the rock paintings in the region, which people say have never been documented.

The farmers agreed to revive *pagaraa*s but were still wary of turning the traditional structures into cemented ones. Among them was Halaku Patel of Albati village in Karauli. "We were suspicious when Gram Gaurav activists approached us. We were happy in our daily struggles of rearing animals and part-time farming, and feared losing whatever land we had," says the 60-year-old, smoking *hookah* on a wooden bed under a tree.

"We used to barter dairy products such as ghee for sorghum and pearl millet. I first tasted wheat when I was 25," he says. "We used to go south-west to rear animals till the late 1980s. But by then, the prey base of wild animals had shrunk because of unabated deforestation. They started attacking our animals. The shepherds of the Marwar region also started bringing their sheep and goats. This led to overgrazing. We once had a bloody fight with them," says Patel. All this led them to think of alternative livelihood. They turned to farming, but they would barely harvest a tonne of wheat from a hectare.

By 2006 Patel and other people in his village were finding it difficult to sustain. "Our cattle was not getting enough fodder and the barter system was virtually dead. After the meeting that year, I decided to take risk. I am happy I did so," says a beaming Patel. Wheat production in his farm has tripled. Patel's *pagaraa* was the third in the region. Fellow Albati residents, Ramji Lal and Ram Swaroop, constructed such water harvesting structures in 2007. Gram Gaurav has constructed more than 170 *pagaraa*s in 365 villages in Karauli and adjoining districts.

The non-profit has also built other water harvesting structures (see 'An oasis for cattle'). As a result, the rocky area now has patches with thick layers of soil. "The land does not need regular irrigation. We irrigate it once a season and the moisture accumulated in the soil takes care of the rest," says Patel. Gram Gaurav's effort has led to more than 80 hectares of agricultural land in an area where once only acacia trees thrived.

"Agricultural production has gone up three to four times," says Radha Shyam, an activist of the non-profit. Gram Gaurav provides cement, skilled labourer, while the community supplies stones, chips, sand and labourers, whenever a *pagaraa* is erected.

"These water warriors are like Lord Krishna. We were poor Sudama. I have only one complaint. Why did they come so late into our lives?" asks a grateful Patel. ■

An oasis for cattle

In Baraki village of Rajasthan's Karauli district, even a camel-cart is rare. But people from surrounding villages with their cattle regularly visit this difficult-to-access village to use Baraki's huge water storage structure, an anicut. The structure which holds enough water even in scorching April is built on the Ankwala nala, a seasonal stream. "People here told us it is the lowest point in the region, so water stays there for the longest period," says Jagdish Gurjar, a Gram Gaurav activist. "We decided to construct an anicut here."

Pirbhulal, a resident, says people in the area had to travel nine kilometres so that their livestock could drink water. "We had planned a well to preserve drinking water. But it needed at least ₹1 lakh," says Phoolchand, 45, another resident. "The concern of Baraki and surrounding villages like Lakhnaki, Nureki, Khateki, Kularaki and Daulatiya to provide drinking water to cattle was met after the construction of the anicut in 2006," says Kuldip Singh, secretary of Gram Gaurav.

The anicut in Baraki village provides drinking water to cattle from at least six villages in Karauli district

Rivulet resurrected in 45 days

Thousands of people working under NREGS bring a 38 km stream back from the dead in Uttar Pradesh

JITENDRA, *Fatehpur*

Thirty nine-year-old Ram Ishwar gave up farming to pull a rickshaw outside the railway station in Uttar Pradesh's Fatehpur town. He says scarcity of water and a resultant increase in the cost of irrigation rendered farming unprofitable. Wheat production from his 0.4 hectare (ha) farmland shrank from one tonne to half a tonne in a harvesting season.

However, a unique initiative to revive the Sasur Khaderi-2 rivulet in Fatehpur district has given a ray of hope to the many small farmland owners like Ishwar in the district who were forced to quit farming.

The ambitious programme under the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) employed over 4,000 workers every day for over a month to de-silt of the dried up rivulet that once flowed into the Yamuna. The project, which is one of the biggest MGNREGS initiatives in the country, was executed between April 15 and May 31 this year.

Riding on its success, state agriculture production commissioner Alok Ranjan on December 2 asked the 70 district magistrates in the state to replicate the model in their districts to raise the groundwater table.

The dry story

Fatehpur district, which is 150 km south of state capital Lucknow, faces acute water crisis despite the Ganga and the Yamuna rivers flowing in the north and south of it. The district also has several small rivulets and lakes, including Pandu, Nun, Rind, Bari Nadi, Chhoti Nadi, and Sasur Khaderi-1 and 2.

A remote sensing report by the state government, published last year, says the groundwater level in six blocks of the district is critical and it is semi-critical in seven others. The report has classified four blocks as dark zone, which is a region where the groundwater level cannot be replenished. Also, in the absence of a path for the rivulet, which acts as a drainage during monsoon, rain water floods surrounding villages, requiring evacuation every year.

Reacting to the problem, local authorities decided to revive the Sasur Khaderi-2 rivulet, which had disappeared due to siltation, prolonged drought and encroachment.

The authorities, led by the then district magistrate Kanchan Verma, decided to revive the 46-km rivulet that originates from a lake in Thithaura village and then carves out its course through four blocks of the district. The rivulet touches 42 villages before reaching the Yamuna.

In the first phase of the project, it was decided to de-silt the lake and 38 km of the rivulet. The length of the rivulet was divided into 38 equal parts and the depth of the rivulet was increased by 20 cm every 1 km to maintain its natural flow.

Arvind Jain, executive engineer in Uttar Pradesh's public works department, who worked on the project, claims 38 technical assistants, who were made in-charge of 1 km each, were trained to carry out the excavation. Labourers were deployed at an interval of 1.5 metres in three rows, he says. "A small island was also planned inside this lake which would provide shelter to the migratory birds," says Jain.

A rocky start

Two of the biggest challenges of the project were to track the course of the rivulet and to take the people in the

Over 4,000 people worked every day to revive the Sasur Khaderi-2 rivulet

Sasur Khaderi legend

The Hindi words *sasur khaderi* mean a father-in-law (*sasur*) chasing away his daughter-in-law. Legend says that a long time ago a daughter-in-law and her father-in-law were planting paddy saplings. The father-in-law was purposefully handing over too many saplings to the daughter-in-law, waiting for her to commit a mistake. However, the daughter-in-law planted the saplings properly. A surprised father-in-law hid behind a bush to see how she was working. He was surprised to see that the daughter-in-law, who possessed divine powers, undressed herself and the saplings got spread on their own. He got offended and chased her away from the village. She then turned into a rivulet and joined the Yamuna.

region into confidence for the project.

The district administration, in response to an RTI application seeking information on the course of the river in December 2011, admitted it had no documents to prove that such a rivulet existed.

Finally, the rivulet was chosen for revival on the persuasion of Swami Vigyananand and other local activists. Vigyananand, 58, has worked towards a pollution-free Ganga in the last decade.

Vigyananand says the district magistrate was initially unwilling to take up the job. He then met Ranjan, who, on March 11 this year, called a meeting with the MGNREGS commissioner, district magistrate and activists for the revival of the river.

"The task was mammoth not only because of its size, but also because of the fear of law and order problem while removing the encroachment on the riverbed," says Verma. The resentment to the project can be gauged from the fact that only 100 workers turned up on the first day of the project on April 14. It required over 4,000 workers. The district administration then carried out sensitisation drives to motivate the villagers to carry out the task. As part of the drive, over a thousand students from schools across the 42 villages volunteered to start the work as community service.

The project hit another roadblock when Thithaura residents wanted the boundary of the lake to be demarcated after excluding their farmlands. They said that instead of their farmlands, the project should include a 23 ha area adjoining the lake which is earmarked as pastoral land in government records. "Geographically, this pastoral land is a part of the lake. But government documents show it as pastoral land, so we cannot include it," admits Jain. Angry panchayat members moved a no-confidence motion against Thithaura village head Prema Devi for siding with the authorities. "I finally approached the district magistrate who stopped the motion against my wife," says Lal Singh, husband of Prema Devi.

The work had to be stopped on June 1, which was two weeks before the deadline, due to early monsoon.

Convergence is key

The project became a success because the government departments worked in tandem under MGNREGS.

The irrigation department lent technical support to construct the canal, desilt the lake and the rivulet. "Without their help, the project would have taken a long time," says Harishchandra, the project director of the District Rural Development Authority, who supervised the programme.

The district land revenue department surveyed the land records to check encroachment and the forest department took up the job of planting 3,500 saplings around the lake.

"The computerised land record of the revenue department helped in precise demarcation of the rivulet's path and in identifying the encroachers," says Verma.

Also block development officers, District Rural Development Authority officials and village heads worked together to arrange the labourers, issue e-muster rolls, and ensure weekly payments and MIS feeds were done.

MGNREGS helps

"Revival of this river would not have been possible without MGNREGS and the convergence of other departments," says Harishchandra.

The scale of the project was so vast that villagers from panchayats in six blocks—Teliyani, Bhitoura, Hathganm, Haswa, Vijaipur and Dhata—were roped in for the project. Officials say most villagers had to travel long distances for the job and they were compensated for it.

It generated 204,900 persondays of work, out of which 156,900 persondays were generated from the restoration work of the river and 48,000 persondays were generated at the lake site. "At the end of the project, the average district persondays touched 90 from 30 last year," says Harishchandra.

The project also ensured that all MGNREGS guidelines, including arrangement for drinking water, medical facility and resting sheds at the work sites, were followed.

Harishchandra says village heads claimed the project lacked people's support not only because they were against the anti-encroachment drive but also because payments are usually delayed in MGNREGS projects. Bank of Baroda volunteered to maintain bank accounts of the workers and transfer the wages every week. Nikhil Gupta, the Bank of Baroda official who worked on the project, says: "As I started transferring the money to the accounts of 100 labourers. The success spread like wildfire and the number of labourers multiplied every day."

"As the project became big, we opened a bank kiosk at the Thithoura lake work site for updating bank records every day," says Harishchandra.

The project has brought water back in the Sasur Khaderi-2 rivulet which was earlier silted and encroached upon by small farmers

JITENDRA / CSE

Change is visible

Though the project is in progress, its impact is already visible. A government survey in August this year found that there was comparatively less waterlogging in fields during the rainy season.

Government officials say areas like Bhairwan and Phulwamau, which never grew paddy crop due to shortage of water, successfully grew paddy this year. The lake has already started retaining water. In July, the lake had 90,000 cubic metres of water. The administration also claims no village has been marooned due to flooding this year.

Farmer Sukhdev Yadav says he normally grew paddy in 0.4 ha of his two ha because of waterlogging. "But this year, I grew paddy in the entire two ha."

Somesh Bahadur a farmer of Rawatpur village, says he could cultivate his land because of the project. "This year, water stayed in the stream. We pumped it into fields when needed," he says.

Dharampal, 32, who worked at the Thithoura lake site, claims the water level in his village has gone up. An excited Jay Narayan Singh of Hasnapur village says that after the success of the first phase of the project, the villagers "will organise a protest, if the new district magistrate does not complete the project".

New district magistrate of Fatehpur Abhay Kumar says he plans to take the work to the next level. "I am consulting adjoining districts like Kaushambi and Allahabad to revive a few other streams which traverse across these districts," says he. ■

The measure of a scheme

Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), the world's largest public wage programme, has glaring anomalies

MOHANA / CSE

It was a veritable mother of all schemes. The UPA government's flagship rural employment programme, under the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), sought to create tanks, ponds and wells and revive traditional water conservation structures at a scale and pace not witnessed before in the country. Millions of people in the countryside seeking jobs under the programme embarked on building or reviving 5.5 million water conservation structures, as per the Union rural development ministry (MoRD). In the six decades before 2005, all the public wage schemes together had created just about two million structures.

The MGNREGA, credited for the ruling United Progressive Alliance's (UPA's) re-election in 2009, has emerged as the world's largest public wage programme. During 2006-07 and January 2013, the central government spent close to ₹200,000 crore on the programme or about ₹83 lakh for every panchayat. Of this, the spending on water conservation structures was close to ₹120,000 crore.

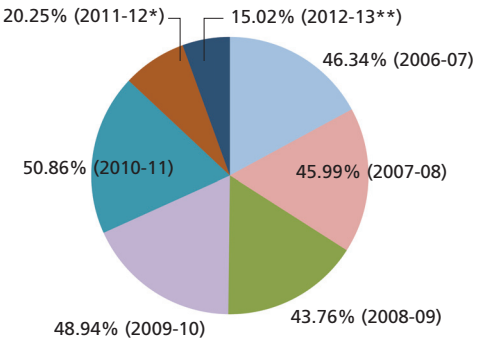
The programme assures 100 days of manual

MGNREGA WORKS COMPLETED (IN FIGURES)...

Year	Total works taken up (in lakh)	Work completed (in lakh)
2006-07	8.35	3.87
2007-08	17.89	8.23
2008-09	27.74	12.14
2009-10	46.17	22.59
2010-11	50.82	25.85
2011-12*	74.13	15.01
2012-13 **	71.03	10.67
Total	**296.13**	**98.36**

*As on 30.01.2013 **As on 30.01.2013
Source: Forty-Second Report, Parliamentary Standing Committee on Rural Development, 2012-13

...AND IN PERCENTAGE



employment to any rural household that demands work. Under the Act, creation of water conservation structures is compulsory. As a result, today Indian villages have more per capita water structures than hospital beds, school teachers and policepersons put together. Official data shows every village has eight-nine such structures. In fact, the programme claims the added capacity is 3.07 billion cubic metre under water conservation and renovation of traditional waterbodies during 2006-11. This can take care of the drinking and cooking water needs of the country. Irrigation channels dug under the programme cover enough distance to make two return trips to the moon.

Arguably, these structures should have created a huge water harvesting capacity, and the programme itself should have led to an economic boom in villages. Every structure gives two benefits: cash as wage and increase in agricultural productivity due to water availability. The National Council for Applied Economic Research in 2009 found that 60 million people were taken above the poverty line because of the programme. The rural development ministry claims per household earning nearly doubled between 2006-07 and 2010-11.

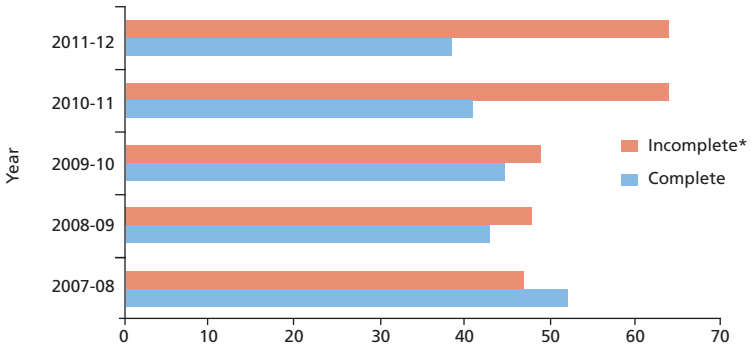
Shouldn't India be celebrating this feat? No, say villages across the country. Thousands of water structures, each a potential money spinner and each initiated under this programme, lie abandoned today. Reasons vary from wage delays to lack of planning to taking up structures without factoring in the capacity of local institutions. For instance, the Jharkhand government decided to dig 112,307 traditional wells under MGNREGA to overcome drought. But the decision came too late — by that time the monsoons had arrived. Since most of the wells were incomplete, they collapsed.

During 2006-2011 (till September), only around 1.2 million water conservation works could be completed, while the rest are either in progress or suspended. The number of works suspended or in progress has steadily risen since the inception of the programme in 2006, from 0.25 million to 2.54 million (in 2011).

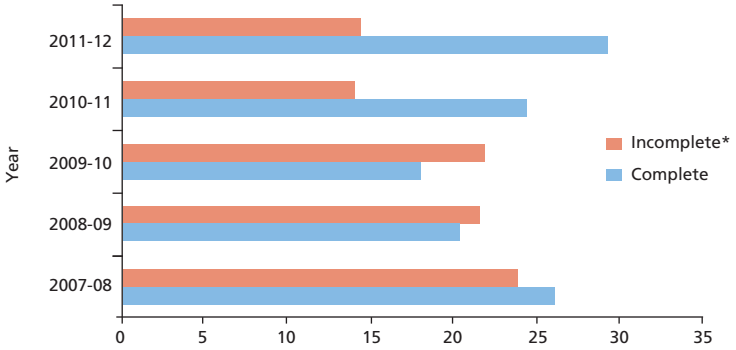
At the national level, the percentage of water conservation works to total works undertaken is declining steadily. In 2006-07, completed water conservation works accounted for 48 per cent of the total completed works. This decreased to 38 per cent in 2011-12. Road connectivity works, on the other hand, have picked up. "Roads have become more popular because they are cost-effective and can be outsourced to contractors. This leads to greater possibility of money

WATER STRUCTURES V ROADS

Waterworks (As percentage of total works)



Rural connectivity works (As percentage of total works)



*Incomplete works include in-progress/suspended works and those approved but not in progress; *Source: Union ministry of rural development*

DURABLE ASSETS CREATED UNDER MGNREGA

Type of works	Total no of works started (2006-07 to 2012-13*)	% of total works	Total works completed
Flood control and protection	533862	3.87	349681
Water conservation and water harvesting	3567527	25.86	1723651
Drought proofing	1645789	11.93	561267
Micro irrigation works	979464	7.1	5321159
Renovation of traditional waterbodies	802526	5.82	530005
Total water conservation and water-related works	**4049168**	**54.58**	**8485763**
Provision of irrigation facilities to land owned by SC/ST/LR or IAY beneficiaries/small and marginal farmers	1502023	10.89	778034
Land development	1570057	11.38	1142293
Rural connectivity	2686227	19.47	1734674
Bharat Nirman Rajeev Gandhi Sewa Kendra	29700	0.21	9729
Other works	469463	3.40	314300
Coastal areas	4		0
Fisheries	325	0.002	30
Rural drinking water	179	0.001	4
Rural sanitation	6747	0.05	231
Total	**13793893**	**100.00**	**12465058**

*As on 12.12.2012
Source: Forty-Second Report, Parliamentary Standing Committee on Rural Development, 2012-13

siphoning," says Ved Arya, director of the non-profit SRIJAN, the programme implementing partner, and member of the Central Employment Guarantee Council.

Missing annual village plans

But are the 1.2 million completed works yielding benefits? Anantapur district in Andhra Pradesh, the first to implement the Act, provides some answers. Under the employment guarantee programme, an average of 38 water conservation works have been created in each of the district's 3,384 villages. In the past two years, the district has dug 8.5 million cubic metre of trenches, 30,000 farm ponds and 10,000 percolation tanks, including rock dams. This potential can irrigate one crop in around 70 per cent of the district's farms. In reality, the impact has been very different.

The district is one of the driest in the country. MGNREGA has all the ingredients to stop desertification, but stopping desertification has not been planned as its priority action. In the first two years, one of the major works identified was building earthen bunds for water harvesting. But the bunds were built in black soil that cannot hold water. Though hundreds of rock-fill dams have been constructed, many hold water only for a few days. "When there's no water, villagers take away the rocks for other purposes," says A Ramachandra, a farmer in Gandlaparthy village of Raptadu mandal.

The most common complaint is non-involvement of the community in planning the structures as stipulated by the Act. Under the Act, each village is required to prepare an annual plan based on local needs. This plan indicates the types of works to be undertaken. At the district level, all the village plans get consolidated into a district perspective plan that spans over five years.

From 2006 till August 2011, Dungarpur in Rajasthan spent ₹482.6 crore on 31,614 water structures. Between August 2010 and July 2011, the state claimed to have created 20 billion litre of additional water capacity. This would imply availability of 30 to 50 litre per person per day. But the district continues to be declared drought-affected. Cultivable land has increased only marginally in the past five years.

Five years of experience has exposed fault lines in the public wage programme. The first is lack of planning. Village plans are not prepared before works are taken up. Without advance planning, procedures such as administrative approvals and technical sanctions add to delays. The panchayats have not been trained to run the programme. Perspective plans are mostly prepared at the district level, so there is a disconnect between what is planned and what people need. Second is a lack of understanding of local ecology. A water conservation structure is critically linked to its catchment that spreads over more than one village. While planning for a village, this aspect is never factored in. The third reason for a large number of works being abandoned is the 60:40 wage-to-material ratio permitted under MGNREGA. ■

LAKES LOST

Among India's many mutinies are the ones around its rivers and lakes. We bring you some of the more strident struggles in the lake districts

Dal lake, Jammu and Kashmir
Encroachment and pollution have shrunk the lake from its original size of 75 sq km to around 12 sq km today. In 2000, local NGO filed a writ petition

Sukhna lake, Chandigarh
Siltation has reduced the lake's area from 230 ha to 154 ha (2007). Petition filed against Haryana government's plans to develop townships in the area was dismissed in court

Lakes of Udaipur, Rajasthan
Udaipur has four large water bodies. In 1997, Jheel Sanrakshan Samiti (JSS) filed a PIL in Supreme Court. The case was directed to the Rajasthan High Court

East Kolkata wetlands, West Bengal
Designated as a Ramsar site in 2002, these wetlands are the lifelines of Kolkata. Spread over 12,500 ha, they are perhaps the largest system of wastewater treatment in the world. In 2006, an NGO filed a petition alleging the Kolkata Municipal Corporation was planning to encroach on the wetlands by building a water supply project at Bointala in Dhapa

Bhoj wetlands, Bhopal
Faces threats including siltation due to soil erosion of the catchment area and inflow of untreated sewage and wastewater from surrounding human settlements

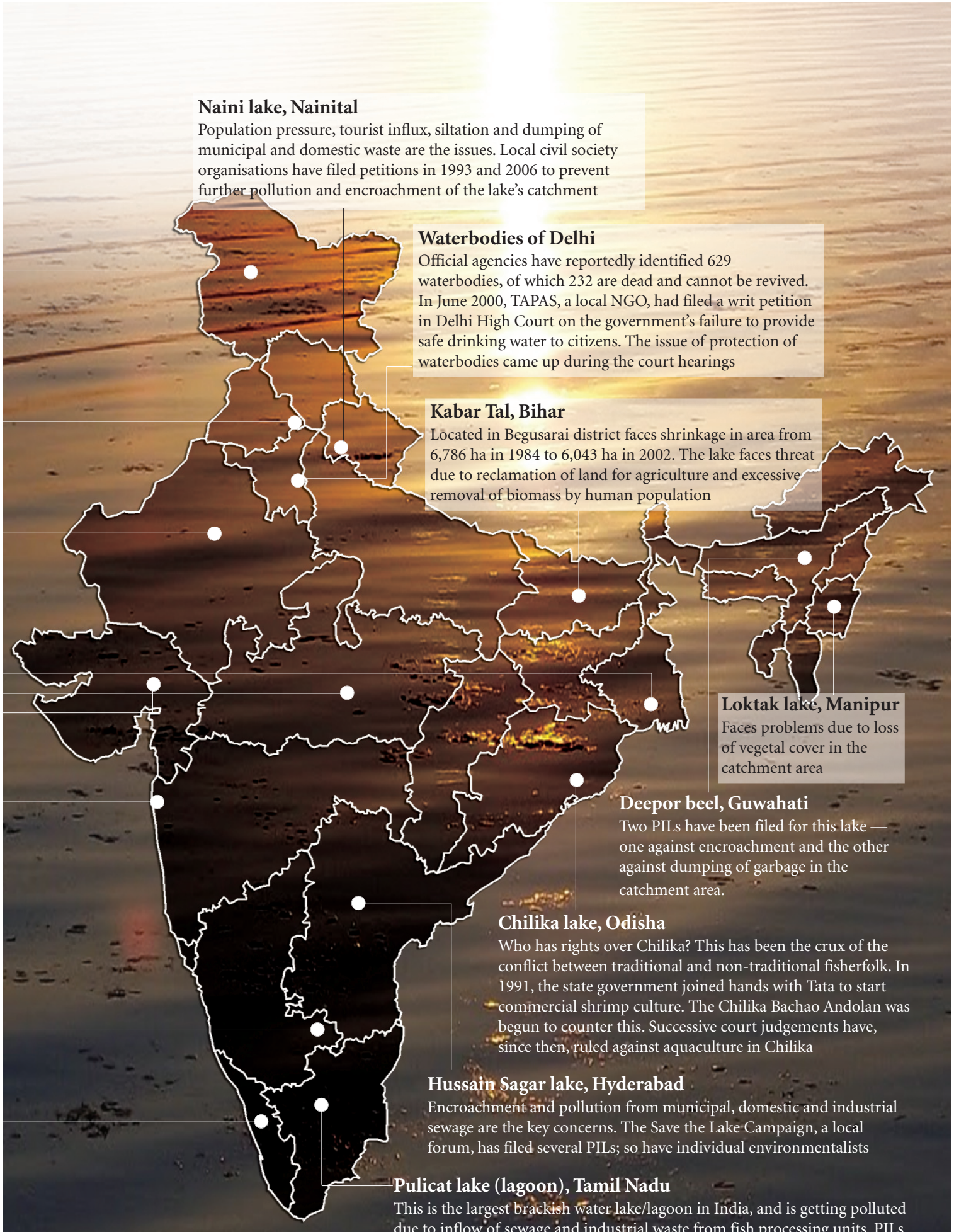
Chandola lake, Ahmedabad
Encroachment is a concern. In 2000, Shailesh R Shah, a resident, had filed a PIL in the High Court

Powai lake, Mumbai
Forty per cent of the lake has disappeared because of encroachments and disposal of sewage. In 2000, a petition was filed by residents to direct the Bombay Municipal Corporation to beautify and desilt the lake

Lakes of Bengaluru, Karnataka
There were 262 lakes in Bengaluru in 1961; today, only 33 are visible on satellite imagery. Pollution and encroachment have been major issues. In 2002, the Lake Development Authority was constituted, which proceeded to lease out lakes to private parties to 'develop' them. Late conservationist Zafar Futehally was the first to file a PIL to save the lakes. In 2008, the Environment Support Group and Leo Saldanha tried to stop privatisation by filing another PIL

TG Halli Reservoir, Bengaluru
A source of drinking water, this reservoir is suffering from flow of industrial wastes into it. In 2009, local villagers filed the PIL which challenged the decision of the state to allow a hazardous waste treatment plant to be set up near the reservoir

Vembanad wetland, Kerala
Spread over four districts, Vembanad is at the heart of Kerala's backwater tourism. Discharge of sewage from surrounding areas, uncontrolled mining of shells and sand, and building of barrages over the water body have led to the lake reducing to 37 per cent of its original area. In 1999, an authority formed by the Kerala government for the integrated development of islands in the backwaters proposed reclamation of 362 ha in the lake. Various organisations have filed cases to save the waterbody



Naini lake, Nainital
Population pressure, tourist influx, siltation and dumping of municipal and domestic waste are the issues. Local civil society organisations have filed petitions in 1993 and 2006 to prevent further pollution and encroachment of the lake's catchment

Waterbodies of Delhi
Official agencies have reportedly identified 629 waterbodies, of which 232 are dead and cannot be revived. In June 2000, TAPAS, a local NGO, had filed a writ petition in Delhi High Court on the government's failure to provide safe drinking water to citizens. The issue of protection of waterbodies came up during the court hearings

Kabar Tal, Bihar
Located in Begusarai district faces shrinkage in area from 6,786 ha in 1984 to 6,043 ha in 2002. The lake faces threat due to reclamation of land for agriculture and excessive removal of biomass by human population

Loktak lake, Manipur
Faces problems due to loss of vegetal cover in the catchment area

Deepor beel, Guwahati
Two PILs have been filed for this lake — one against encroachment and the other against dumping of garbage in the catchment area.

Chilika lake, Odisha
Who has rights over Chilika? This has been the crux of the conflict between traditional and non-traditional fisherfolk. In 1991, the state government joined hands with Tata to start commercial shrimp culture. The Chilika Bachao Andolan was begun to counter this. Successive court judgements have, since then, ruled against aquaculture in Chilika

Hussain Sagar lake, Hyderabad
Encroachment and pollution from municipal, domestic and industrial sewage are the key concerns. The Save the Lake Campaign, a local forum, has filed several PILs; so have individual environmentalists

Pulicat lake (lagoon), Tamil Nadu
This is the largest brackish water lake/lagoon in India, and is getting polluted due to inflow of sewage and industrial waste from fish processing units. PILs have been filed in 1994 and 2000

Source: Centre for Science and Environment
Map not to scale

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Water Programme Unit
Centre for Science and Environment
41, Tughlakabad Institutional Area
New Delhi - 110062

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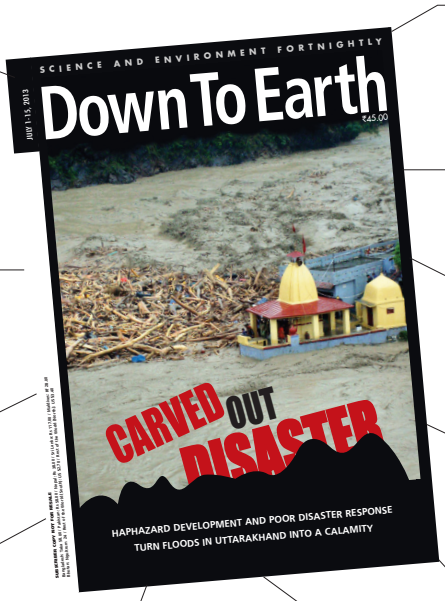

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