The precarious situation of India’s water problem

economictimes.indiatimes.com/news/politics-and-nation/the-precarious-situation-of-indias-water-problem/articleshow/57965416.cms

Hari Pulakkat

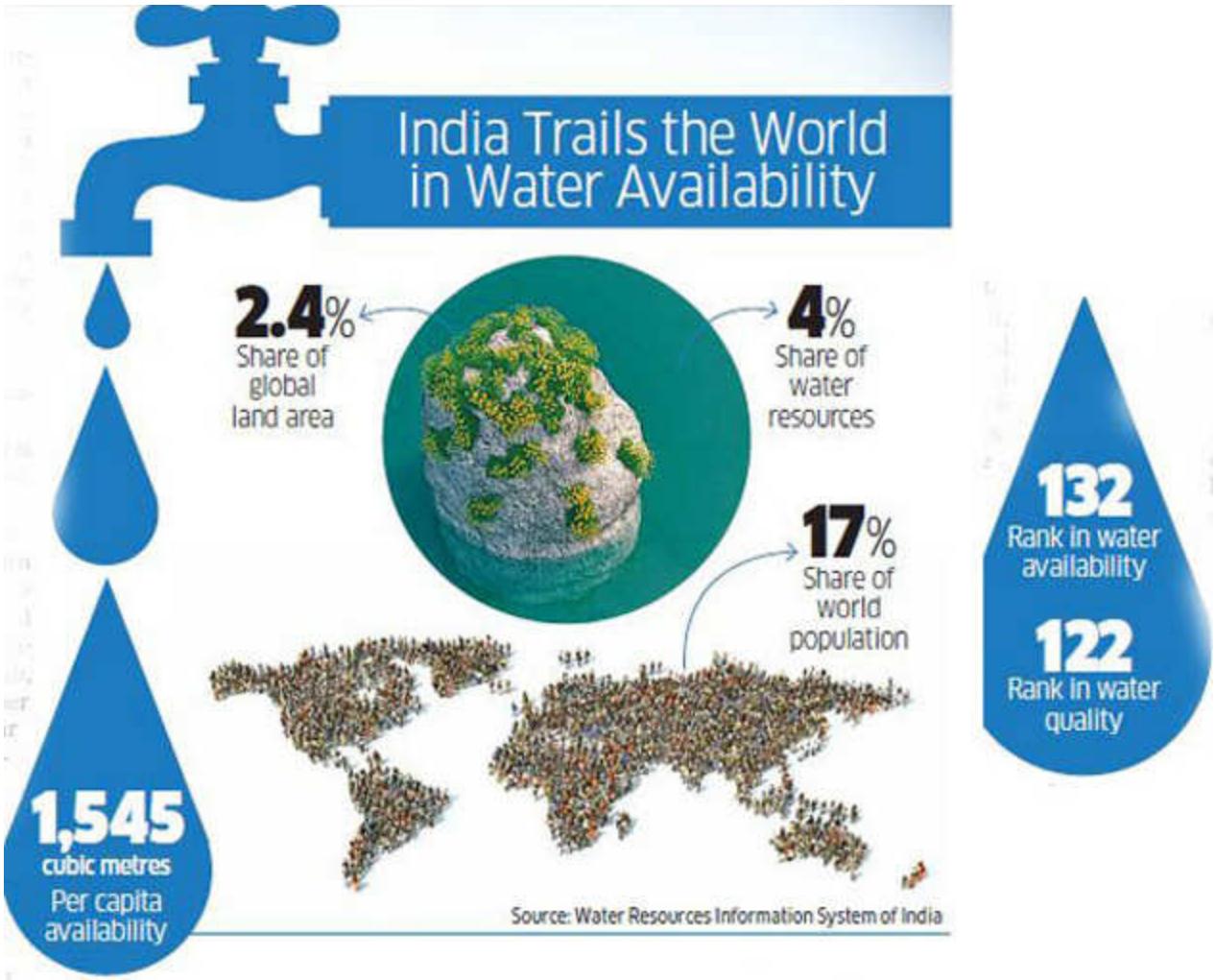
A reduction in pollution over the subcontinent combined with a significant increase in forest cover can keep a weakening monsoon in check, up to a point.

As a ground water hydrologist, Indian Institute of Science (IISc) professor Sekhar Muddu had not paid sufficient attention to measurements of evaporation and transpiration, two phenomena commonly described by a ponderous word called evapotranspiration. Muddu was attracted to this concept 10 years ago when he heard a talk by TN Narasimhan, then a professor at the University of California in Berkeley, US.

Narasimhan, now deceased, was drawing the attention of hydrologists at the IISc to a curious fact. He thought that the ministry of water resources had no real data behind its assumptions of evapotranspiration, and that the numbers they used were an underestimate.

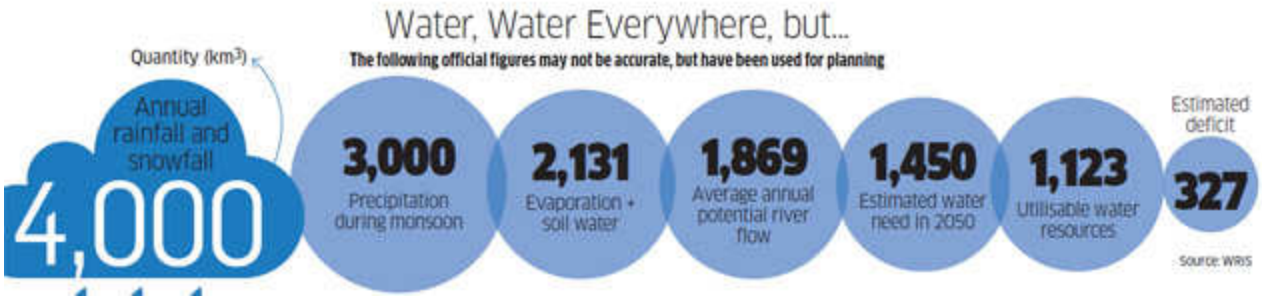
If his hunch was correct, said Narasimhan, India’s water situation was worse than what the government had imagined.

Narasimhan published his analysis as a paper in the Journal of Earth System Science in 2008, arguing that India’s available water was far less than what policymakers had assumed.



The topic of evapotranspiration became a point of discussion among India's hydrologists and policymakers, and Muddu decided to put the idea to test. Narasimhan had not made any measurements in India, but had based his arguments on measurements made in other countries with features similar to India. Muddu found a PhD student, R Eswar, interested in studying evapotranspiration.

They decided to measure how much water is lost in the country every year to evapotranspiration. Eswar was deeply interested in remote sensing. He figured out ways of calculating evapotranspiration from satellite data, with some verification through ground stations set up with the help of the Indian Space Research Organisation. In three years they had an evapotranspiration map of the country. Eswar left last year for Jet Propulsion Laboratory in the US for his postdoctoral research, but a product from the research team is getting ready, promising policymakers and scientists data that can be used to analyse the country's water situation accurately. "We found that planners had used low estimates of evapotranspiration," says Muddu. "It means that we have less usable water than we had thought."



This piece of seemingly bad news is actually good, according to Muddu. The IISc product provides detailed information about how evapotranspiration is distributed throughout the country.

It is high in Punjab, Haryana and the upper Ganges states Uttar Pradesh, Uttarakhand and Bihar. It is low in the southern states. “In the Punjab and the upper Gangetic plain,” says Eswar, “the evapotranspiration is equal to the annual rainfall.” In fact, in some places in the northern plains, evapotranspiration is higher than the annual rainfall.

In the Western Ghats and Arunachal Pradesh, it is about 50% of the annual rainfall. “Understanding evapotranspiration,” says Sekhar Muddu, “allows us to reduce it and thus increase the available water.”

The Table on Water

Water is a precious but dwindling resource for India, but till a decade ago the country had very few hydrologists who could model the state of its resources using advanced methods. As more scientists began to study ground water, river flows and evapotranspiration, they ran into a serious problem that affected the quality of their work. The country’s water data were largely hidden from public view, and what were available were poor or untrustworthy.

Their predicament led to a question that had been valid for a while but rarely asked directly by the policymakers. If scientists found it difficult to analyse the country's water resources at the moment, what was the validity of reports that forecast the country's water future? In 2009, McKinsey published a report on global water which said that India would be able to meet only half of its water demand by 2030. The McKinsey report, produced with the help of a new internal team called Water Resources Group, became widely cited by governments around the world. In India, subsequent reports had used this figure to justify action or changes to the way the country handled its water resources. India's hydrologists, meanwhile,

do not quite foresee such a dire situation. Not because they think that the future is good, but because they don’t know. Rainfall forms one of the key inputs for modelling the country’s water future. India now has good rainfall measurements spread around the country, and so has good data on what happens throughout the year.

443 million school days are lost each year due to water-related diseases

For $1 invested in water and sanitation, there is an **economic return** of between $3 and $34, says WHO

Girls under the age of 15 are twice as likely as boys to be the family member responsible for fetching water

In developing countries, as much as **80%** of illnesses are linked to poor water and sanitation conditions.

Nearly **1 out of every 5 deaths** under the age of 5 worldwide is due to a water-related disease

Source: The Water Project

Forecasting rainfall is a different matter. Monsoon forecasters struggle with even seasonal forecasts. Knowing what will happen in the future as the earth warms up is a hard task. Climatologists work at it, but no real breakthrough seems to be at hand.

Farmers need accurate weather forecasts, as they have to take decisions on when to sow or water a crop. Hydrologists and policymakers are interested in predicting India's water budget, the amount of water that is available for use every year. Fortunately, to understand the future water budget, they do not need very accurate monsoon forecasts. They need to know whether the total rainfall will increase or decrease.

Most climate models say that it will increase with temperature, but no one is sure. Models have not predicted past monsoon behaviour well, and so why should we believe what they say about the future? The monsoon has shown a decreasing trend in recent times, but some meteorologists think that this decrease may be partly due to natural variability. "We have seen decades of drought earlier," says Ravi Nanjundiah, director of the Indian Institute of Tropical Meteorology (IITM) in Pune, "and the monsoon has picked up later. But we have not seen an excess rainfall year recently." The last excess rainfall year was in 1994, and it worries meteorologists.

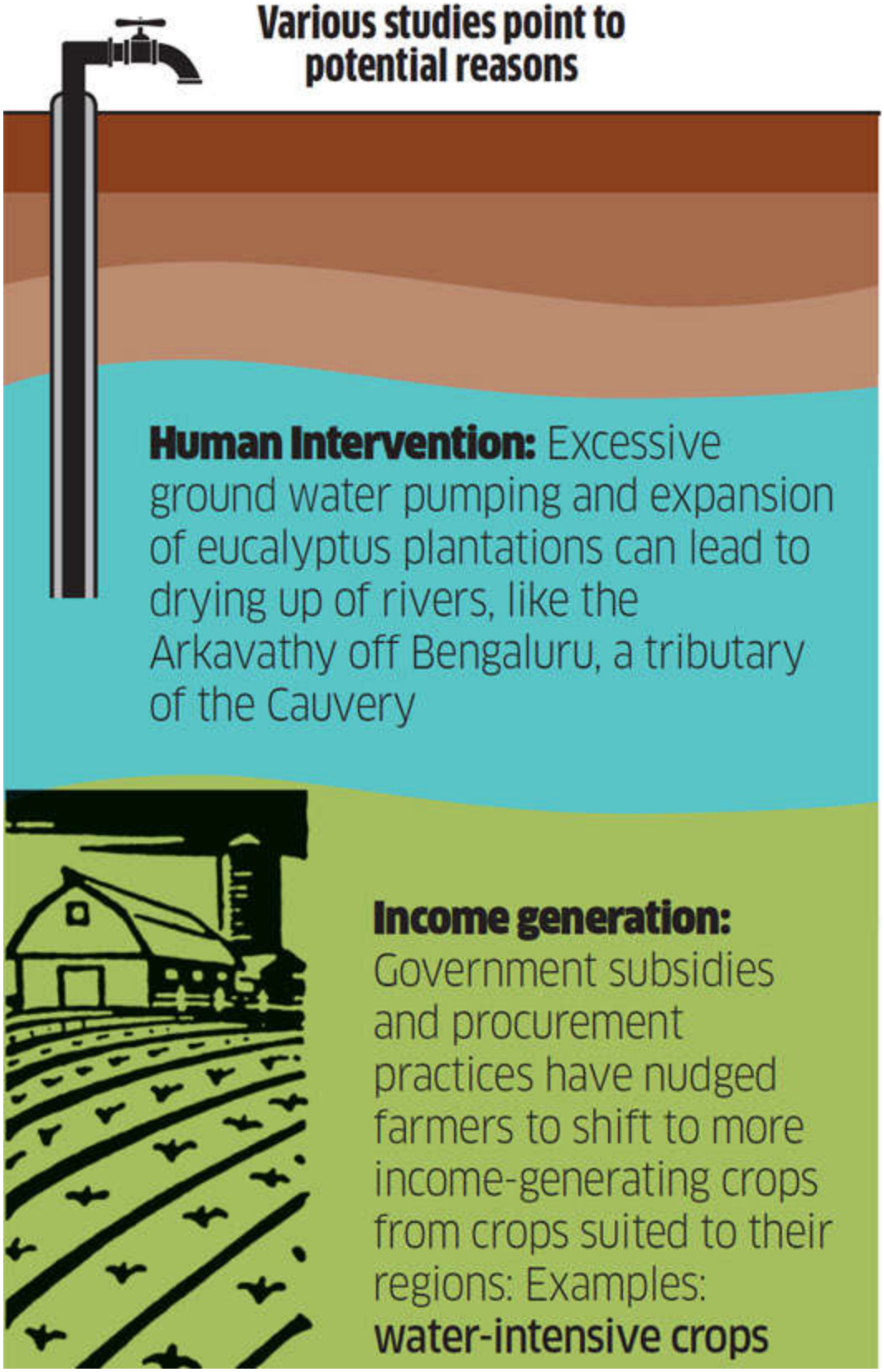
Vimal Mishra of IIT-Gandhinagar and his colleagues have been studying 40 widely used climate models more closely, and they provide some interesting observations. Mishra divided these models into three: those that predict the monsoon well in the past, those that predict the past monsoon poorly, and a mixture — called an ensemble in scientific parlance — of all the 40 models. He found that while the best models forecast a decrease in the monsoon strength with fewer rainy days and more frequent droughts, the worst models show an increase in the monsoon intensity, and the ensemble falls somewhere in between.

This work is still in progress and not yet published, but Mishra's initial observations do not present a rosy picture.

"The last decade has been the driest in the last 116 years," says Mishra. "It is not good news if the rains decrease and the temperature increases." We are not certain about rainfall, but there is no uncertainty about temperature. Increasing temperatures are a double whammy: they increase both ground water pumping and evapotranspiration. Both ground water and surface water availability decrease.

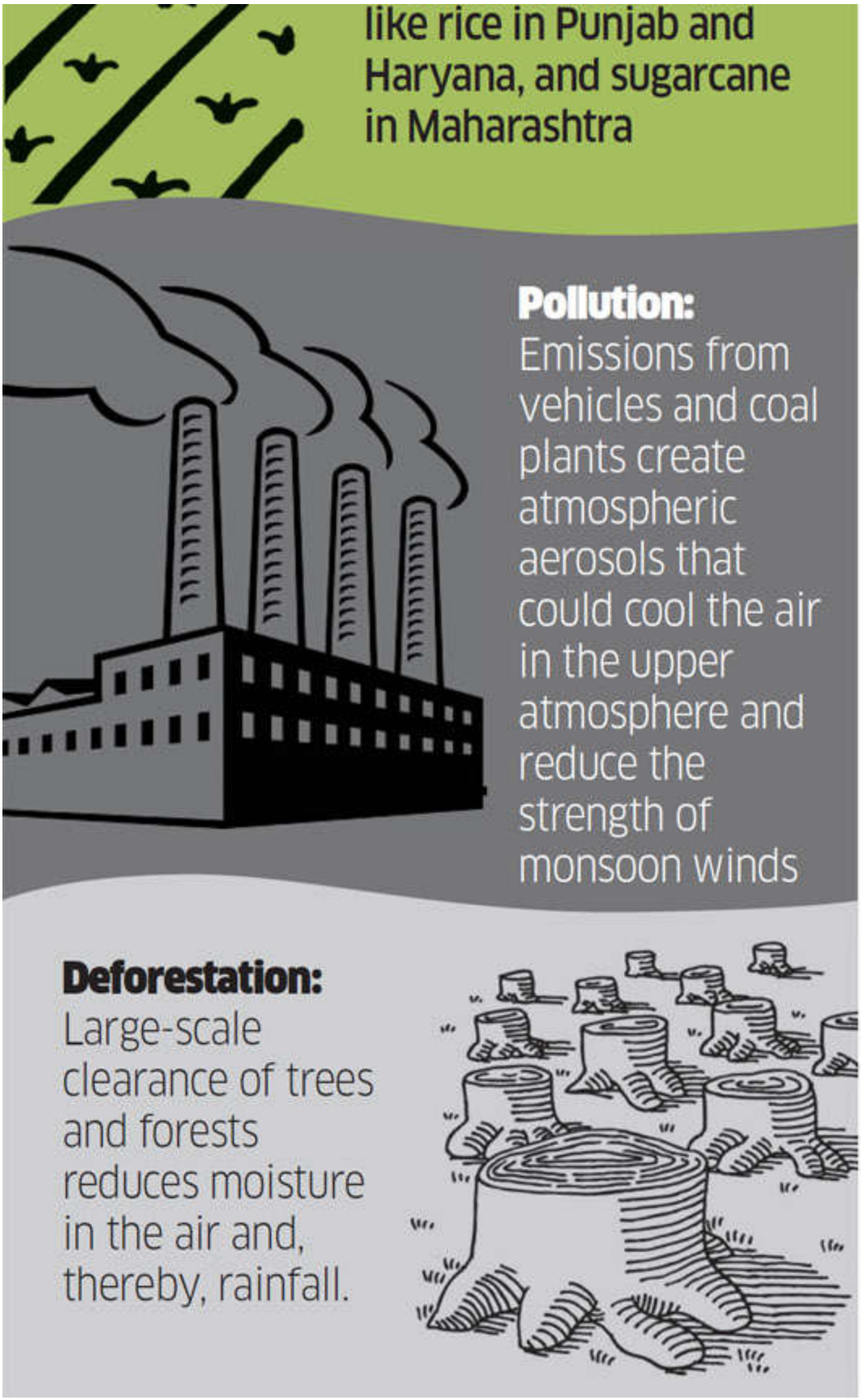
Why Water Levels are Reducing

Various studies point to potential reasons



Human Intervention: Excessive ground water pumping and expansion of eucalyptus plantations can lead to drying up of rivers, like the Arkavathy off Bengaluru, a tributary of the Cauvery

Income generation: Government subsidies and procurement practices have nudged farmers to shift to more income-generating crops from crops suited to their regions: Examples: **water-intensive crops**



In a paper published in Geophysical Research Letters, Riddhi Singh at IIT-Hyderabad and her collaborator showed that different parts of the country will show different effects of similar

decreases in rainfall. She found that South India is the most vulnerable, where a 10% decrease in rainfall can produce a 25% decrease in water availability.

It is a scary scenario, with a high probability of becoming a reality, but not necessarily written in stone. Climatologists are yet to understand the global processes that influence the monsoon. As the temperature goes up, the relationships between the monsoon and the rest of the world can change, as parts of the ocean warm up faster or currents change direction.

Data Dry

Rainfall data is a key input for modelling. Data about river flows and ground water pumping form two other important inputs. Hydrology in the country has been hampered by lack of data, but there has been some change recently. The government has made public data about peninsular river basins, but flow data on the three major north Indian rivers — Indus, Ganga and Brahmaputra — are still not widely available. Without data, how would hydrologists model the north.

Indian river basins?

Political sensitivity and security are the reasons usually given for not making such data public. All the three rivers flow from India to neighbouring countries, and Indian diplomats do not want them to get data about flows through India. Such sensitivities are now unusual, as other countries share data about rivers that flow through many countries.

The Danube river basin is one example. The Mekong River Water Commission consists of officials from Cambodia, Laos, Thailand and Vietnam, and high quality data are available about the lower Mekong river basin.

Even within peninsular India, where data are available, their quality had been questioned repeatedly by several experts. About seven years ago, the Planning Commission constituted a working group to assess water quality data and make recommendations to improve them. “We submitted our report in 2011,” says economist A Vaidyanathan, who was a committee member, “so far not much has happened.” Some of the poor data can be attributed to faulty sensors, some to incorrect conversion of units and some due to apathy and reluctance of state administration to share data.

Sugar Isn’t Sweet

It is thus no surprise that hydrology studies are limited in scope within the country. Small studies, however, have been throwing up interesting results. Veena Srinivasan, a hydrologist at the Bengaluru-based Ashoka Trust for Research in Ecology and Environment, has been studying the Arkavathy river near the city. The Arkavathy is a tributary of the Cauvery, and its flows have been declining steadily since the 1970s. A reservoir on the river is now operating at only 20% of its capacity. Data on the flows were extremely poor in quality, and Srinivasan did field surveys and secondary data to test a few hypotheses.

She found that the drying up was not likely to be related to climate change, and seemed to be the result of human interventions like excessive ground water pumping and expansion of eucalyptus plantations.

Data about human interventions on the other river basins are not widely available, and so many studies have ignored them in their models. “Humans have altered watersheds so much but models had been run almost as if we did not exist,” says Srinivasan. Widespread human interventions make Indian river basins the most complex in the world, and very difficult to model even with rich data.

Studies in some of the IITs and other institutions on ground water and river flows have produced insights into the fundamental nature of the country’s water problem, and thus provided hints about reversing the declining water availability. It is now well-known that agriculture is the main driver of ground water pumping. Studies by Upmanu Lall and his colleagues at Columbia University have shown that government subsidies and procurement practices have made farmers shift from growing crops suited to their regions to those that provide more income.

Lall’s prime exhibit is rice cultivation in Punjab, Haryana and parts of the Gangetic plain. Rice is a water-intensive crop, not suitable for cultivation in northern and north-western India. Subimal Ghosh at IIT-Bombay has also studied the problem, and found that low electricity tariffs are also a driver of ground water depletion. “Low electricity tariffs make farmers pump water even if the soil is saturated,” says Ghosh. Ground water is the main source of water in an erratic monsoon year, and advanced technology and the right policies can reverse some of the depletion, but some of the causes are not easily solved.

Hydrologists now agree that large-scale cultivation of sugarcane is a major reason for water scarcity in some areas, especially in Maharashtra. Sugarcane is a water-intensive crop, and consumes more than two-thirds of Maharashtra's irrigation water. If you disregard the amount of water required to grow the crop, it is quite good for the farmer. "Sugarcane is not labour-intensive and is lucrative for the farmer," says Vikram Patil, agricultural economist and senior specialist at the International Rice Research Institute at Bhubaneswar. "It is grown in areas with labour shortage and is not easy to replace." Patil is also the son of a sugarcane farmer.

According to economists and hydrologists, sugarcane and rice show a non-intuitive aspect of water use in the country. "A lot of farming is not about food," says Veena Srinivasan. "It is about jobs." Farmers will switch to other crops or other occupations if they have options, and can help improve the water usage. Through the export of rice, India also exports several trillion litres of water virtually. Should a water-scarce region export so much virtual water?

As data improve and hydrologists come up with real insights into the country¡¦s water problem, they could also suggest interventions to reduce its severity. Some insights are already available, and they overlap with common sense: shift the cropping patterns, recharge

ground water, use advanced technology for irrigation, reduce sand mining in riverbeds and so on. Even with all these interventions, a rapid weakening of the monsoon can still create severe water stress in most of the country. Are interventions possible here?

Pollution and Monsoon

Meteorologists have studied the causes of the apparent weakening of the monsoon. Two human causes stand out: atmospheric aerosols and deforestation. Pollution, especially from vehicles and coal plants, creates atmospheric aerosols that could cool the air in the upper atmosphere and reduce the strength of monsoon winds. This idea is not fully proven, effects of different aerosols on the monsoon can vary, but the overall impact is considered negative. Deforestation also reduces moisture in the air and thus rainfall.

At IITM, scientist R Krishnan has looked in depth at the causes for declining rainfall. The actual experiments are very complex, but his results can be summarised quickly. Deforestation and aerosols indeed seem to be the main culprits, and they will continue to reduce rainfall till the 2060s. Aerosols seem to be the biggest contributor, and it is not from India alone. Aerosols over China have a big impact on the monsoon, and so do those over the entire northern hemisphere.

A reduction in pollution over the subcontinent combined with a significant increase in forest cover can keep a weakening monsoon in check, up to a point. And, of course, so does a reduction in carbon dioxide emissions, but those are not fully in India's control.

Why is it so hard to understand our water requirements in the future?

There is not enough monitoring of water flows through rivers in the country, and often data about river flows are not released. Humans have interfered with the natural water cycles through dams and ground water extraction. Data about these interventions are also inadequate.

Why is it so hard to get good data about water use in India?

State-level agencies collect water data. Collection of data is not always monitored and controlled for quality. Even when data are available, state agencies have been reluctant to share them because of inter-state disputes and political sensitivities.

Why does excessive ground water withdrawal reduce flow in rivers?

In India, the monsoon lasts only for four months and there is little rainfall in summer. Rivers get their flow in summer through a process called base flow, which is actually ground water oozing through the riverbed. Low groundwater levels reduce base flow, and hence summer flow in the rivers.