Invisible pollution

The total global water resource comprises 94% salt water (oceans and sea), 2% ice (polar ice caps and glaciers) and only 4% freshwater. Out of this total (4%) freshwater, only 1.5% is available in rivers, lakes, streams, etc. and the balance 98.5% of total freshwater is groundwater. With freshwater bodies of surface water being polluted at an alarming pace and due to increasing demand for freshwater for diverse activities of the ever-growing population, groundwater resource, which was once believed to be pristine and protected, is more under potential threat than ever before.

Let us look at the breakup of global water consumption: 75% of the world's freshwater is being used for agriculture, 20% by the industries and 5% for domestic purposes. Major portion of freshwater that is consumed by agricultural sector re-enters the hydrosphere through rivers and lakes and ultimately find its way into groundwater aquifer system through hydraulically connected surface water-bodies that are highly contaminated.

We do not have comprehensive database on the status of contaminated sites and groundwater pollution in our country. Groundwater pollution in Tamil Nadu's Pallal basin (due to indiscriminate disposal of tannery waste water), organic pollution of groundwater near Mysore, Karnataka (due to distillery waste water), recent contamination of water at Bichhri village, Rajasthan are only a few examples to quote. Arsenic contamination in the Ganges aquifer system of West Bengal and Bangladesh is presumed to be the manifestation of over-exploited groundwater resources.

Indiscriminate land-based disposal of hazardous waste, application of pesticides, unlined and poorly maintained surface impoundments, poorly constructed septic tanks, infiltration of domestic sewage from unsewered areas, underground storage tanks of petroleum and gasoline products and chemical spills are all potential sources of groundwater pollution. If preventive and corrective action is not initiated immediately, many of our groundwater aquifers will get contaminated and result in serious water resource crisis and pose a public health risk.

There are some demonstrated technologies which are promising for cleaning-up contaminated aquifers. New technologies that are evolving include soil vapour extraction, *in situ* bioremediation, bioventing, air sparging, *in situ* thermal desorption, soil flushing, *in situ* reactive barriers, etc. Inaccessibility and inherent complexity of subsurface system, impracticable time scales required for the clean-up, complex technologies and ultimately the cost, pose formidable challenges for effective and efficient practical implementation of these technologies. If any aquifer is once contaminated, it will be extremely difficult if not impossible to treat and remediate, especially for a country like India.

The action plan for groundwater protection has to be based on:

- Detailed characterization and preparation of baseline database for the entire country's groundwater system.
- Classification of aquifer systems with respect to quantity, quality, utility as well as present and projected pollution status.
- Surveillance and monitoring of groundwater system for pollution by federal and state regulating agencies through a permanently established and well-designed system of monitoring network on a continuous basis.
- Establishing the network of interactive information system among the state and federal regulating agencies, research institutes and local monitoring cells.

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More Bradmans

I enjoyed reading the piece 'The Bradman class' (*Curr. Sci.*, 2001, **80**, 717–718). J. D. Watson and F. H. C. Crick were, however, not so classified. Among the 20th century scientists, they deserve that class. Pauling had proposed a model of DNA (published in *Proc. Natl. Acad. Sci. USA*) before the Watson and Crick paper in *Nature* in 1953. According to him, the bases stick out. That did not solve anything. Chargaff found A is equal to T and G is equal to C, but he did not know what it meant. It was Watson and Crick who proposed that: (1) bases stick inside and pair by H-bonding, A with T and G with C; hence G = C and A = T; (2) for replication, the two strands unzip and act as templates for synthesis of two new strands; (3) the two strands are anti-parallel which helps in H-bonding of A–T and G–C; (4) the sequence of bases is unique for each gene and codes for a specific protein; and (5) a change in a base causes a mutation.

All these are original and outstanding interpretations of the limited data that were available at the time. Watson and Crick were certainly the ones who made biology, physics and chemistry join hands. Without their elucidation of the DNA structure, there would not have been a gene revolution so early in the 20th century. What is remarkable is the amount of information that they could draw out by proposing a simple model of DNA. If the five conclusions mentioned above had been made at different points of time, their impact would not have been as great as that made by the 1953 *Nature* paper. For example, Chargaff's data of G = C and A = T hardly made an impact on biologists, as he did not interpret the data. He did, however, express his annoyance for not sharing the Nobel prize.

I would, therefore, raise both Watson and Crick to the 'Bradman class' for their far-reaching interpretation of the limited data and for their insight into the DNA molecule which made possible the understanding of 'information flow in living organisms', the genetic code, genetic engineering and all the rest. It is praiseworthy that they continue to contribute to science at such high gear even after half a century.

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Academic leadership and the ailing state of Indian science

Indian institutions have not produced even one Nobel prize winner since independence, despite proliferation of very many universities and a large number of national research institutes. Concerns regarding the decline in academic and scientific quality in India have also been voiced recently. R. Kalshian[1], referring to the decline in quality of research in India states that, 'In the entire history of CSIR, only three out of over 20,000 papers published by its scientists have been cited more than 100 times against a world average of one out of every 250'. This may constrain people to infer that the functioning of the national research institutes is far from being satisfactory, since there is an asymmetrical relationship between the funding and their performances. This may be possible because in the post-independence period the high priests of academic and scientific organizations, instead of confronting the political bosses to defend quality and truth like Asutosh Mukherjee and others of pre-independence period, have become the messengers of political bosses and behave like chameleons depending on the political bosses. P. V. Indiresan, former Director of IIT, Madras has vividly compared the happenings of the pre- and post-independence period and has said[1], 'As a Vice-Chancellor Asutosh Mukherjee could straight away make Raman the Palit Professor in Calcutta University . . . Those days Vice-Chancellors were 10 feet tall. These days, their counterparts are pygmies. How did that happen?'.

These 'pygmies', devoid of adequate academic quality and integrity, in their capacity as Vice-Chancellor/Director tend to be scavengers of quality and settle for second raters and third raters. In the process merit and quality are sacrificed and the entire generation suffers. As a result, academicians with courage, integrity, conviction and originality are becoming casualities of the system justifying Gresham's law, i.e. bad money drives away good money out of circulation.

If India has to make a mark it is necessary to preserve, protect and defend quality in human capital. This cannot be assured without ensuring the quality of the Vice-Chancellors/Directors because they play a vital role in ensuring/damaging the quality of the institutions which serve as gold mines of human quality.

In the absence of an objective assessment of quality, judgments are mostly subjective and prejudiced and result in the selection of Vice-Chancellors of poor calibre, in spite of an elaborate procedure involving the University Grants Commission, Chancellor and the Syndicate vicariously. A similar situation holds true for research institutes. A corrupt and incompetent bureaucracy further contributes immensely to the said selection. Clearly, an objective assessment of quality through citation counts – the acid test of quality – has become mandatory[2], in addition to other prevailing criteria for the selection of Vice-Chancellors, Directors and other personnel for top academic positions. Only men of quality can preserve, protect and defend quality. As a result quality will breed merit and merit will no longer be a casualty and a glorious India can be assured.

1. Kalshian, R., *Outlook*, 23 October 2000, pp. 56–66.
2. Basa, D. K., *Curr. Sci.*, 2000, **79**, 1042–1043.

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Need for reforms in Indian National Science Academy

I was delighted to read the column 'News in brief' in *Current Science* (2001, **80**, 726) regarding the reforms and restructuring of Indian National Science Academy (INSA), proposed by Goverdhan Mehta, the President of INSA. As a matter of fact, restructuring of INSA has been long overdue in view of the changing scenario at the global level. INSA has been acting more or less like an exclusive 'White man's club' in India. It is one of the most prestigious science academies in the country. Unfortunately, after the independence, university academia have found less and less representation in its elected fellows compared with the scientists from institutes like TIFR and IISc. It may be considered as an index of decline in quality of research produced by our universities.

The President of INSA deserves all praise for introducing innovative ideas for the election of INSA fellows. Due recognition will be given to scientists working in inter-disciplinary areas of research by creating a separate sectional committee to consider their nominations. I know many physicists working in border-line or cross-border disciplines being ignored year after year, as there was no