# From green revolution to evergreen revolution

In the guest editorial by Kesavan and Swaminathan[1], the authors present pathways and terminologies for achieving goals of ecological and economic sustainability. Recalling the benefits and problems associated with green revolution, the need for evergreen revolution has been advocated. The phrase evergreen revolution according to the authors, is the best available option to meet the goals of sustainability (increasing productivity without harming natural resources). To usher this transformation, adoption at farm level of one, more or a combination of approaches which are embedded in phrases like green agriculture, eco-agriculture, effective microorganisms, white agriculture, one-straw revolution, etc. are suggested as a pathway. Without going into the merits of these (and there are many more) approaches, it is our contention that adopting these approaches as a way to operationalize the sustainability concept, could be inappropriate. Achieving goals of sustainable agriculture calls for a knowledge base, which is much deeper and wider than what we have today. Complexities inherent to the sustainability concept demand new ways of defining science agenda and in organizing and doing science. Advocating and equating sustainability to one or more of these approaches would be restrictive to good agricultural science becoming a pathway to sustainability goals. Managing complexity through these approaches will be too simplistic an approach to operationalize sustainability paradigm.

1. Kesavan, P. C. and Swaminathan, M. S., *Curr. Sci.*, 2006, **91**, 145–146.

I. P. ABROL
SUNITA SANGAR*

*Centre for Advancement of Sustainable Agriculture (CASA),*
*NASC Complex, DPS Marg, Pusa,*
*New Delhi 110 012, India*
**e-mail: sunitasangar@yahoo.com*

# Urban flooding: Can it be ignored any further?

Come monsoon, the peril of flooding starts looming over the metropolitans, be it Mumbai, Delhi, Kolkata or even smaller cities spread over the length and breadth of country. Since the experience of Mumbai and Chennai in 2005, urban flooding has assumed the notorious distinction of causing imponderable loss of life, property, public facilities, interruption of social and occupational activities and above all, a deep impact on the social psychology. The post-flood rehabilitation and reconstruction imposes a heavy unplanned cost on the public and government and eats away a major time of the administration. It takes a long time to replenish the contaminated aquifers and control the mosquito breeding. As a ritual, pre-monsoon announcements of preparedness are made which are more of a confidence-building nature than pragmatic approach of flood avoidance. Flooding is not a new phenomenon, though its frequency and magnitude are on rise, primarily due to sudden spurt in the incessant rains which some people fear to be a precursor of the climatic shift. It is believed that unpredictable heavy rain is a factor over which we have little control. However, we can still do a lot to tame and utilize the flood water in urban areas.

The mechanism of urban flooding is complex and site-specific. It could be due to heavy rains[1], river overflow[2], release of water and coastal hurricanes and a combination of any of the above. However, topography, drainage, rainfall and lithology always play the determining role[3]. Unfortunately, these parameters are seldom considered vital in our urban planning. This is the reason that most of our cities are flood-prone. Surat is the latest example of this problem.

In the Indo-Gangetic plain, many of our big cities are located on the riverbanks. Initially, the cities were small and confined to the upland areas, outside the river domain. Their haphazard extension to the river lowlands has made them vulnerable to flooding. In addition to the river flooding for which several measures are available, we are witnessing flooding of cities by moderate to heavy intensity rains for which appropriate preventive measures are yet to be evolved. It is observed that anthropogenically superimposed concrete topography overwhelmingly influences the origin and augmentation of flooding. The concrete pavements and buildings produce three types of effects; they reduce the seepage, increase the level of water and obstruct its lateral movement to the sink. Studies have shown that pavements and apartments reduce percolation of water up to 90% (ref. 4). The vertical structures also create multiple sub-basins of different size and shape with poor interconnectivity. Among them, the smaller sub-basins respond quickly to the rains and cause instant flooding.

Now, can we allow such repeated devastating events when the economic and social stakes of our cities are increasing rapidly? The problem of urban flooding, therefore, needs to be tackled in its totality. It requires integration of expertise from earth science, engineering and meteorology. In the beginning, we need to develop a database on the emerging rainfall pattern, geomorphology, structure and composition of the urban areas. The planners have to be trained and educated to understand the significance and implication of these inputs in designing the city layouts with due concessions to the hazardous conditions.

However, in the densely urbanized areas, scope for arranging flood mitigation measures becomes limited owing to massive construction and non-availability of space. At places, it is difficult to enhance the capacity of existing drains and/or to lay down new flood drains. In such areas new options have to be explored. One

option is to construct storage tanks[5] at appropriate places where a part of the floodwater could be stored and then released or reused subsequently. The second option is construction of seepage holes and wells, similar to those made for groundwater recharge, through which a part of flood water could be transferred to sub-surface aquifers. In both cases, the space requirement and disturbance to the existing environment is low and the structures are easy to make even in the densely urbanized condition. An additional advantage will be of replenishing the water table, which is on decline in most of the urban areas.

1. Dhar, O. N. and Nandgiri, S., *Mem. Geol. Soc. India*, 1998, **41**, 1–25.
2. Kale, V. S., *Mem. Geol. Soc. India*, 1998, **41**, 229–256.
3. Saini, H. S., Mujtaba, S. A. I. and Pant, N. C., *Geol. Surv. India Spl. Publ.*, 1996, **48**, 101–107.
4. Leopold, L. B., *U.S. Geol. Surv. Circ.*, 1968, **554**, p. 18.
5. Terstriep, M. L., Voorhees, M. L. and Bender, G. M., *Illinois State Water Survey Publication*, 1976.

H. S. SAINI

*Geological Survey of India,*
*N.H. 5.P., NIT,*
*Faridabad 121 001, India*
*e-mail: sainigsi@indiatimes.com*

# Paradigm shift in water resources development and management

Rapid population growth, changing living standards and irrigation requirements were mainly responsible for the enormous expansion of water resources infrastructure in the twentieth century. Water resources development in the past century completely ignored the hidden costs of the environmental loss, viz. the destruction of ecosystems, dislocation of human population, inundation of cultural sites, disruption of sedimentation processes, etc. Economic analyses were generally done with incomplete information.

But, in the past two decades, there has been a major paradigm shift in water resources development and management. The old paradigm based on the philosophy of larger dams and reservoirs has begun to fail. People are now more concerned about environmental loss and economic and social issues. High value is placed upon the maintenance of the integrity of water resources and the flora, fauna and human societies that have developed around them. Both Union and State Governments are under tremendous pressure to ensure equitable distribution of costs and benefits of water resources development projects. Efforts are constantly being made to understand the diverse interests and fulfil the needs of the affected stakeholders.

The new paradigm is directed towards 'water use efficiency' by reducing wasteful applications of water, by changing cropping patterns, by reducing losses between the field and the source and by many other methods. Water use could be sustainable by increasing the efficiency with which current needs are met and by increasing the efficiency with which water is allocated among different users. Where additional or new supplies are necessary, major new projects must now compete with innovative small-scale approaches, including micro-dams and other locally-managed solutions. Greater reliance on groundwater resources could be an excellent solution, and efforts should be made towards new source finding and its development. In addition to this, non-traditional sources of supply could play an increasing role, including harvested rainwater, reuse of recycled wastewater and desalinated seawater.

The greatest drawback in the twentieth century water policy was the failure to understand the connections between water and ecological health. The objective of the twenty-first century water management should be to understand these connections and make a balance between the ecological health and human water needs.

PRADEEP K. NAIK*
DINESH PRAKASH

*Central Ground Water Board,*
*Central Region, N. S. Building,*
*Civil Lines,*
*Nagpur 440 001, India*
**e-mail: pradeep.naik@water.net.in*

# Research in biotechnology: A lucrative career option

The biotech sector is the fastest growing industry in the world today, surpassing the growth of the IT industry. Given the global environmental conditions and the increasing demand for safer and better products, millions of dollars are being invested to find solutions to critical problems of health, food and environment.

Scientific research in biotechnology and related areas has come of age and is emerging as a career which can prove lucrative and provide a social stature. Indian molecular biologists working in research institutes, universities and laboratories have begun to develop indigenous technologies and selling them to companies at prices which may be meagre on a global level but unheard of in India. Technologies developed and sold for anthrax vaccine and blood clotting streptokinase are just a couple of examples.

The biotechnology sector, propelled by the growth in agriculture, pharmaceutical and medical industry, growing annually at a rate of 45%, would bring in revenues worth $5 billion by 2010 and create close to 1 million jobs[1].

This being a research-oriented field, there is a demand for researchers, scientists and trained technicians with excellent laboratory skills. To meet the requirement of skilled technical cadre, the government provides incentives at every level of education to make this career choice attractive.