CORRESPONDENCE

GROUNDWATER RECHARGE

I read with interest Dr. Radhakrishna's editorial on "Groundwater Recharge", in the August issue of the Journal of the Geological Society of India. For long Dr. Radhakrishna has spoken passionately for a wise use of India's water and natural resources. His commitment and courage are inspiring to all earth scientists. In the August editorial, he pleads for a revival of rainwater harvesting through the construction and maintenance of check dams and tanks in areas where rain falls. He concludes that any talk of recharging the zone up to a depth of 100 metres is a doubtful proposition because of the slow process of recharge.

Rather than commenting specifically on the groundwater conditions in Karnataka in particular and peninsular India in general, I would like to offer some thoughts based on what is known here, in California, in regard to groundwater recharge and water management.

In California, and in the United States, it is being increasingly recognized that surface water and groundwater constitute a single resource, and that they have to be managed as such. The reality of surface water is that a substantial part of the annual rainfall flows off to the ocean and is "lost" during periods of rainfall. Historically, water managers devised ways and means of capturing this runoff or "loss" for "beneficial use". In California, for example, over a third of the runoff to the ocean has been captured over the past six decades for agriculture, industry, and other purposes. However, more recent knowledge gained over the past two decades has brought to focus the fact that the natural runoff and the associated sediment loads have a major role to play in the survival of various plant and animal communities. As a result, water managers in California are increasingly turning towards restoring critical flows in streams that had been deprived of water by upstream impoundments. There is even a move to decommission some existing dams.

The concept of artificial recharge was pioneered in California around 1900 by Eugene Hilgard, a soil scientist, who noticed that by spreading storm waters over coarse-grained sediments of alluvial fans and other permeable formations at the foot of hills where the streams experience a drastic decrease in velocity, the aquifer systems could be effectively recharged. One important finding that goes back to the early groundwater investigations in California at the turn of the 20th century is that a significant part of aquifer recharge occurs from streams. Thus, the early groundwater hydrologists recognized that maintaining flow in streams helps greatly in the recharge of aquifers. Recharge is therefore best achieved by building structures at carefully selected locations.

This idea was effectively exploited in the development of a well-designed, integrated water management system of the Santa Clara Valley, now known the world over as the Silicon Valley. Santa Clara Valley is less than 750 km^2 in area, and constitutes a completely self-contained physiographic unit within which both the groundwater basin and the surface water basin coincide. Sediments derived from the surrounding mountains aggregate a thickness of over 600 metres, of which the upper 350 metres are profusely water-bearing. Over much of the upper half of the valley, the aquifers are under unconfined conditions, but they are confined over the lower parts of the valley. On a basin-wide scale all these aquifers are interconnected. Over a third of the valley's water supplies are derived even today from groundwater. Some wells near San Jose are known to yield about 8 cubic metres per minute (over 2,000 gallons per minute). The Santa Clara Valley Water District owns (on behalf of the people) and manages surface water and groundwater together. Private companies and municipalities buy water from the district or obtain permit to pump groundwater, and distribute them to the public at a cost. Integral to the management of the aquifers is the presence and maintenance of an extensive system of artificial recharge structures in the upper reaches of the valley.

During the 1960s, Santa Clara Valley's water needs exceeded the capacity of its own watershed, even with careful water conservation. It had to import water in large quantities from northern California. Before importation of water, water levels in wells, even in confined aquifers at depths of 150-300 metres, had declined by tens of metres. As soon as the first deliveries of imported water came, they were used directly for artificial recharge rather than being diverted for human consumption. Within a year or two water levels recovered even in deep aquifers. At present, deep aquifers are recharged and their water levels maintained under active production through artificial recharge of indigenous storm flows, as well as imported water, as needed.

What relevance this knowledge has for peninsular India? At the outset, it suggests that surface water and groundwater have to be managed together. Excessive

construction of dams and ponds can substantially reduce contributions to streams, which could go dry. Deprivation of flow in streams can have significant effects on native plants and animals that depend on them. Dams and impoundments at non-optimal locations may contribute to high evaporative losses. Intensive interception of rainwater in upland watersheds can seriously affect water and sediment availability to flood plains. Erosional cycle and nutrient cycle are closely connected. Undue alteration of the erosional cycle by trapping sediments in numerous upstream impoundments will necessarily have long-term impacts on down stream distribution of flora and fauna.

Geologists, hydrologists, and ecologists are beginning to learn that the hydrological, nutritional, erosional and geochemical cycles that enable the existence of all life are in a delicate equilibrium. The greatest challenge to us as earth scientists is to learn to sustain ourselves in such a way that we do not "unduly" disturb these cycles. The future will require thoughtful, talented, and hard-working scientists who can develop sustainable methods for living within the constraints of natural resource systems.

As Dr. Radhakrishna has been pointing out for many years, there is a desperate need for the most talented of Indian scientists and engineers to devote their attention to the study of India's own natural resource problems, identify the central questions, and find answers that are uniquely suited for India's culture, traditions and social values. Traditions and values are important because when we have to make hard choices, as we have to when we have a finite amount of water that needs to be shared by humans and other living things, the choices will be dictated by our unique set of values. It is rather sad that the most privileged of Indian youth, and the most proactive of Indian business people are preoccupied with technology and industry that have the potential for immediate monetary gains. If India does not have good water supply or sanitation, the feeling seems to be that they will "somehow" be taken care of by market forces.

There is every indication that water will play a more telling role than cheap energy in the future economic well-being of countries around the world. One can only hope that the most talented and the most privileged of the Indian society will find it honourable to pursue the study of the earth and its natural resources, rather than capitulating to the lures of modern technology.

T. N. NARASIMHAN

Materials Science and Engineering
Environmental Science, Policy and
Management, Earth Science Division
Lawrence Berkeley National Laboratory
210 Hearst Memorial Mining Building
University of California at Berkeley
Berkeley, CA - 94720-1760
Email:*tnnarasimhan@LBL.gov*

ANNOUNCEMENTS

NATIONAL SEMINAR ON ROLE OF FLUIDS IN THE CRUSTAL EVOLUTION: SPECIAL EMPHASIS ON THE HIMALAYAN MAGMATISM AND METALLOGENY. The Wadia Institute of Himalayan Geology is organising the National Seminar on this topic during 4-5 February, 2004 at Dehra Dun. This will be followed by one day post seminar field excursion on 6 February 2004, depending on the number of interested participants. The aim of the Seminar is to provide a platform to discuss, interact and disseminate knowledge on the various issues of Earth's fluid system. In addition to the geological processes and Indian case histories, emphasis will be provided to the studies of the Himalayan crustal evolution. For further details, please contact: Dr. Rajesh Sharma, Convenor or Dr. H.K. Sachan, Co-Convenor, Wadia Institute of Himalayan Geology, 33, General Mahadeo Singh Road, Dehra Dun - 248 001, India. **Phone**: (0135)2624806, 2620341, 2626335; **Fax:** 0135-2625212; **Email:** fluidsem04@rediffmail.com; rajesh_fluid@ rediffmail.com; himanshusachan@rediffmail.com

COURSE ON APPLICATION OF REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS FOR MINERAL EXPLORATION: The Geological Survey of India Training Institute (GSITI) in collaboration with ISRO is organising this training course at Hyderabad for 10 weeks from 19 January, 2004. For further details please contact: Deputy Director General, GSITI, GSI Complex, Bandlaguda, Hyderabad - 500 068. **Phone:** 040-24220681; **Fax:** 040-24220680; **Email:**gsitihyd@hd2.dot.net.in; and also visit the GSI **website**: www.gsi.gov.in