

which is the number one cancer in Indian males. He described possible therapies like use of cancer terminator viruses that selectively replicate and destroy cancer cells. He also plans to use microbubble-based gene delivery, and AAV vector-based delivery of tumour suppressor genes in oral cancer.

Sujata Mohanty (AIIMS, New Delhi) talked about the use of stem cells in developing gene therapy for rare genetic disorders. She heads the DBT Centre for Excellence in Stem Cell Research and has set up a CGMP facility for handling stem cells of therapeutic quality. Her group has cryopreserved many mesenchymal stem cell lines, following the ICMR guidelines. Quality control is done by karyotyping and marker testing by flow cytometry. This state-of-the-art facility set up by her dedicated efforts will be invaluable for research and therapeutic developments using gene therapy.

The talks by scientists were followed by presentations from industry representatives. Sumathy (Bharat Biotech, Hyderabad) presented the priority areas of her company, which is the leading manufacturer of a large number of vaccines, and is also engaged in clinical trials of many of them. The company has a large GMP manufacturing capability and is knowledgeable about the regulatory procedures.

These assets could be tapped in future endeavours for gene therapy.

Ravinder Makkar (Sanofi Genzyme) pointed out that his company was the first to come out with enzyme therapy for lysosomal storage disorders and supply the enzymes to Indian patients. It is concerned about the lack of clarity in the roadmap ahead, uncertainty in regulatory guidelines, and cost of technology development that are hampering new technology developments in India.

Bhaskar Jyoti Sonowal (Shire) apprised about this Irish company which has entered the Indian market only a year ago. The company is interested in genetic disorders like haemophilia, and is involved in phase 1/2 clinical trial for Factor VIII. However, it could not recruit any Indian patients for the trial as the mechanism for fast-track recruitment of patients is not in place in India. Hence guidelines need to be streamlined for the benefit of patients.

After the presentation of the talks highlighting current level of expertise in the country, a panel discussion on 'Developing gene therapy for rare genetic disorders in India: How to go forward' was held. The discussion was chaired and moderated by Madhulika Kabra (AIIMS, New Delhi). The panelists included Sheffali Gulati (AIIMS, New Delhi), Ratna Puri (Sir Ganga Ram Hospital, New Delhi) and Sudha

Bhattacharya (Jawaharlal Nehru University, New Delhi). All panellists emphasized the importance of gene therapy for ultimately curing patients with rare genetic disorders, as most of the treatments currently available for a few diseases are expensive and require to be taken throughout life. However, they pointed out a number of obstacles that need to be crossed before it becomes feasible to carry out a gene therapy trial in India. These include setting up of integrated multidisciplinary clinical care centres, simplified regulatory guidelines with possibility to carry out exploratory studies, funding support for generating preclinical data and for clinical trials, and GMP production facilities for making vectors and stem cells. The panelists also emphasized the importance of patient groups in this endeavour.

In conclusion, the participants felt that India needs to have a National Mission on Gene Therapy that will allow development of relevant technologies, infrastructure for implementation and time-bound execution plan.

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MEETING REPORT

River rejuvenation*

India is in the midst of a water crisis and is now considered to be a water-scarce country. The Indian Himalayan and Peninsular rivers are fast depleting. To address the water crisis in India, initiatives to rejuvenate Indian rivers have been taken up by both Government and non-Government organizations.

Identifying the type of distortions and planning to revive the natural status is the concept of river rejuvenation under the 'Art of Living' banner. The initiative has been supported by the Government and other corporates. The conference

highlighted methodologies used to rejuvenate rivers in Karnataka, Maharashtra, Tamil Nadu and Kerala. This initiative is now being extended to other states in India.

The aspect related to flow of a river and its rejuvenation was highlighted by K. Subramanya (formerly at Indian Institute of Technology, Kanpur). In the flow of a stream, a combination of surface water and groundwater keeps it running. The groundwater discharges into the stream when its surface water level falls below the water table. During monsoon, run-off from the catchment area drains as streams join the river and generates the flow of the river. Post-monsoon, the run-off tapers and the base flow or contribution of groundwater into the stream in-

creases and feeds into the river for the rest of the year.

Subhajyoti Das (formerly with Central Ground Water Board, Bhubaneswar) provided an overview of endangered rivers in India. Environment and ecological systems are essential to sustain the river flow and water quality. Plants and trees are essential for run-off generation and infiltration of water. Roots of trees and plants help in keeping the soil porous for infiltration and also help in arresting soil erosion. Rivers also sustain aquatic plants, fishes and other aquatic life-forms which help in keeping them pure. Das explained that reduced river flow due to creation of dams, diversion of water, discharge of untreated sewage, overexploitation of groundwater, decreasing base

*A report on the River Rejuvenation conference that was held by the Art of Living Foundation on 5 and 6 December 2017 at Bengaluru.

flows, deforestation, catchment degradation, mining, land-use changes and siltation are some reasons causing perennial rivers to become seasonal and seasonal rivers to dry up.

Lingaraju Yale (Vyakti Vikas Kendra India, Bengaluru) explained the 'Art of Living' methodology adopted for river rejuvenation, i.e. harvesting the rainwater and increasing the water potential both on surface and subsurface. This involves locating proper sites using remote sensing technology, constructing boulder checks, percolation wells, injection wells and water pools to increase the infiltration of water; planting trees to prevent soil erosion and increase soil moisture; rejuvenating biodiversity in the river banks and creating awareness among the people and empowering them.

Relevance of geospatial techniques that include mobile applications, navigational tools such as GPS/NAVIC, GIS and remote sensing to locate proper sites for river rejuvenation were discussed by S. K. Subramanian (Vyakti Vikas Kendra India, Bengaluru). The maps obtained from geospatial techniques on relevant sites and placement of structures are handed over to the execution team through mobile applications. P. G. Diwakar (ISRO, Bengaluru) gave an overview on Bhuvan geospatial platform. Information on precipitation in the air obtained from meteorological satellites, groundwater potential maps on Bhuvan-Bujhal and weekly surface-water-body maps on Bhuvan is available for identification of relevant sites. ISRO through Bhuvan also looks at water body fraction data that can be downloaded for climate models. P. V. Narasimha Rao (National Remote Sensing Centre, Hyderabad) highlighted the role of ISRO in integrated watershed management programme (IWMP), which aims to bring about ecological balance by harnessing, conserving and developing degraded natural resources such as soil, vegetation cover and water. In this programme, prevention of soil run-off, regeneration of vegetation, rainwater harvesting and recharging of groundwater table are being monitored using space technology in the 75,000 micro watersheds that are part of 8200 IWMP projects.

Prabhash Chandra Ray (Horticulture Department, Government of Karnataka) talked about rejuvenation efforts in Karnataka under the MGNREGA scheme. MGNREGA is designed to provide em-

ployment for the unskilled up to 100 days/household. Under this scheme, 60% of the allocated funds is utilized for agriculture and allied activities related to tree-planting, water conservation and land development. Asset creation under this scheme includes construction of boulder checks, percolation wells, injection wells and pools to improve water infiltration.

Evaluation of interventions for groundwater recharge in terms of efficiency, effectiveness, relevance and impact was done by V. K. Hegde (Pixel Softek Private Limited, Bengaluru). Health of catchment, land use/land cover, water depth, water spread, run-off potential, water conservation and recharge structures were evaluated for the mentioned parameters. Socio-economic impact assessment carried out in Kumudavathi river basin was highlighted by Guru Balamugan (Tata Institute of Social Sciences, Mumbai). The assessment was carried out on parameters such as demographic details, agriculture, irrigation, livestock and rural infrastructure.

Inclusive eco-restoration to rejuvenate biodiversity in the river banks and for holistic development of the river valley was discussed by Nagesh Hegde (environmental communicator). He recalled that in the Kumudavathi rejuvenation project, local people and children from nearby schools were educated on biodiversity, and different types of water bodies, and were involved in activities such as planting and monitoring the growth of saplings and cleaning of local kalyanis.

Nagaraj Gangolli (Vyakti Vikas Kendra India, Bengaluru) discussed the community empowerment initiatives undertaken by the river rejuvenation project. This initiative resulted in the creation of a village lab, bringing 40 families in a village under a key coordinator and skill training of these workers to handle work under the MGNREGA scheme. He also discussed the hurdles in terms of getting the action plan approved at the Gramsabha. The action plan has been executed in 10 Gram panchayats and is planned in 22 districts. Ravindra Desai (Vyakti Vikas Kendra India, Bengaluru) emphasized the need for water management on the demand side, once the supply side had been enriched. He also talked about village lab sustenance initiatives such as creation of dairy industries, small-scale oil industries, development of supply

chain and point of sale management for vegetables cultivated by farmers and economical management of cold storage.

V. M. Chamola (HAL, Bengaluru) indicated that HAL-CSR activities have supported Kumudavathi river rejuvenation through development of watersheds. M. I. Ganagi (National Bank for Agriculture and Rural Development, Bengaluru) talked about the mobilization of funds from different sources for environment and watershed development activities.

Pratap Hegde (Telematics4U, Bengaluru) discussed the role of Internet of Things in areas such as river rejuvenation, sewage water management and sand management.

Several alternatives to water management and methodologies used in river rejuvenation were provided at the conference. Roger A. Falconer (Cardiff University, UK) laid emphasis on global pricing of water based on its virtual usage (water used in producing commodities) and better understanding of the virtual water requirement and water footprint. Since hydro-environmental research and engineering and integrated water resource management with a cloud-to-coast approach are now topics of global concern, he suggested that river rejuvenation projects need modelling techniques in addition to field data.

T. G. Sitharam (IISc, Bengaluru) reiterated that artificial recharge of groundwater depends on factors such as surface run-off available, rainfall pattern, land use and vegetation, topography, soil type and depth, hydrological and geological characteristics, socio-economic conditions and infrastructure facilities available, and environmental/ecological impacts of artificial recharge. Highlighting that storage of water (especially flood waters) is a major issue, he recommended the use of geotechnical structures such as check dams, subsurface dams, underground dams and coastal reservoirs as alternatives. He urged rejuvenation teams to focus more on geology compared to geospatial techniques, initiate discussions on the use of geotechnical structures and also evaluate the use of geo-synthetics such as geo-membranes, geo-fabrics/geo-filters in the projects.

V. Ponaraj (Abdulkalam Vision India Movement, Chennai) suggested the linking of rivers to meet the future irrigation, sanitation and quality potable water requirements of India. He also talked about an alternative proposal for creation of a

smart waterways grid at 250 m amsl that can store up to 600 billion cubic metres (BCM) of water to act as a national reservoir. He emphasized the need for a system to harness at least 40% of the 1500 BCM of flood water entering the sea.

The conference concluded with a panel discussion providing recommendations for the current programme and also for evaluating alternatives. The panel recommended developing a holistic and integrated view of the river basins to enable scaling-up of the problem and preparing the action plan based on the

nature of the terrain, while also accounting for aspects related to climate change. The panel also called for more volunteers with local knowledge of terrains to form an integrated team and work with the central team. Suggesting that the methodology requires fine-tuning, recommendations were made for additional focus on socio-economic aspects, rural sanitation, biodiversity and management aspects of rejuvenation projects. The panelists called for integration of the approach in various states and creation of a document for approval by the Government of India. Suggestions were also made to utilize

dying wisdom and traditional knowledge available with the local people.

The recommended alternatives included global water management and costing of water, evaluation of methods for storing water in the sea (coastal reservoirs), utilization of excess flood water, and proportioning water for all seasons along with the introduction of water audits.

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