

Harnessing Isotopes

Smarter Water Management

Water security stands as a cornerstone of sustainable development, particularly for India where rapid population growth, urbanization, and climate change exert immense pressure on freshwater resources. India's water landscape spans wide-ranging diversity from glacial-fed rivers to arid zones, from dense urban centers to remote agricultural regions embedding stark variability in water availability and demand. Managing these resources equitably requires precise scientific tools beyond conventional methods.

Isotope hydrology has emerged as a transformative approach to understanding and managing complex water systems. By measuring isotope ratios of oxygen and hydrogen in water molecules, along with nitrogen, carbon, and sulfur in dissolved salts, scientists can determine water sources, identify contaminants, and assess resource sustainability. These insights inform and contribute to targeted conservation strategies and pollution remediation efforts.

BARC's isotope hydrological programme, initiated in the 1970s, has contributed to deeper understanding of water resources across India leading to sustainable water management practices. Recent applications have expanded to evaluating groundwater resources in urban centers and water-scarce regions, determining natural aquifer recharge rates, and developing augmentation plans to prevent "zero water day" scenarios.

This thematic Newsletter focuses on **"Water Resources and Role of Isotope Technology - Global and Indian Perspective."** It presents articles that showcase important contemporary themes: water quantity and quality assessment, isotope hydrological techniques, surface-groundwater interactions, climate change impacts, global water scenarios, institutional collaborations, and policy frameworks. The article collection presents case studies and research that highlight nuclear-based techniques in water resource assessment and protection, demonstrating the synergy between scientific advancement and practical application. Each contribution comes from eminent authors with extensive practical experience in water resources and isotope hydrology.

As water conservation becomes increasingly urgent, this issue serves as a platform for knowledge exchange, capacity building, and scientific collaboration. The greater integration of isotope hydrology into national water management frameworks can empower scientists and policy makers to address India's water challenges with enhanced precision and foresight, strengthening resilience, equity, and long-term sustainability.

I trust these insights will inspire further research, innovation, and implementation pan-India water landscape. My sincere gratitude to all authors for their valuable contributions and commitment to this vital field. I express my special thanks to Dr. Y. K. Bhardwaj, Associate Director, Radiochemistry and Isotope Group, and Dr. Raghunath Acharya, Head, Isotope & Radiation Application Division for their support and encouragement.

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