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# Water and Sanitation in the New Millennium

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K.J. Nath • Vinod Prakash Sharma  
Editors

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 Springer



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ISBN 978-81-322-3743-3

ISBN 978-81-322-3745-7 (eBook)

DOI 10.1007/978-81-322-3745-7

Library of Congress Control Number: 2017950011

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Printed on acid-free paper

This Springer imprint is published by Springer Nature

The registered company is Springer (India) Pvt. Ltd.

The registered company address is: 7th Floor, Vijaya Building, 17 Barakhamba Road, New Delhi 110 001, India

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## Foreword

The global importance of water, sanitation and hygiene for development, poverty reduction and health is reflected in the United Nations Millennium Declaration, in particular its eight Millennium Development Goals, in the reports of the United Nations Commission on Sustainable Development and at many international fora.

In India, the successive governments launched several flagship programmes like the National Mission for Clean Ganga, Jawaharlal Nehru National Urban Renewal Mission, National Rural Drinking Water Quality Monitoring and Surveillance Programme, and, more recently, the Swachh Bharat Mission and Smart City Mission. However, the planning and implementation of these programmes and methodologies/technologies adapted need critical review and evaluation. The National Academy of Sciences, India (NASI), being a premier organization of scientists, engineers and health professionals, is seriously concerned about the prevailing situation in respect of community water supply and sanitation practices and its very critical impact on community health. We sincerely feel that it is necessary for the leading scientists, technocrats and health professionals and the sector leaders to sit together and deliberate in depth about the maladies and seek remedial and corrective steps. In the above context and as conceptualized and planned by Dr. V.P. Sharma and Prof. K.J. Nath, NASI organized the **1st Policy Support Brainstorming on Safe Water and Sanitation for Rural and Urban India** in collaboration with WHO and Sulabh International Social Service Organisation (SISSO) in July 2009. It was a highly successful event attended by distinguished scientists and technical experts from all over the country. Along with the **Allahabad Declaration**, a set of precise and scientific recommendations were adopted which were forwarded to all the concerned departments. As a follow-up of the brainstorming, participants formulated a number of research and development proposals which were forwarded to the Department of Science and Technology. Further, for an in-depth deliberation and review of the progress in the sanitation, water supply and environmental management sector in the context of the policy and programme of the government, the academy organized **the 2nd National Brainstorming in Allahabad**, on 20–22 September 2012, in collaboration with SISSO. The recommendations of this event were particularly contextual in the sense that a comprehensive policy initiative was suggested at the national, state and local levels.

Dr. V.P. Sharma (who left us in October 2015 for the heavenly abode) was very much concerned about the continuing crisis in the water and sanitation sector in

India. Prof. K.J. Nath and Dr. Sharma deliberated on the issue and proposed the 3rd Brainstorming in November 2014 which was approved by the council and organized successfully. Meanwhile, it was felt that the papers presented during the 2nd Brainstorming should be published for larger dissemination among the scientists and professionals in the country. Altogether, 24 papers were presented in 7 thematic sessions. Issues and critical challenges facing the country, on various aspects, were discussed during these sessions. This book is the compilation of those presentations in a systematic manner, so that the valuable information/data generated out of the deliberations will be stored for helping the policymakers and programme implementers in a scientific way.

I am very much grateful to Prof. K.J. Nath, the late Dr. V.P. Sharma and all other contributors for this valuable treasure. The contributions of the distinguished authors are of critical importance and would be extremely useful for the scientists and professionals, working in the sector, to engage in further deliberations and suitable actions.

NASI  
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Akhilesh K. Tyagi

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## Preface

World Health Assembly 1998, Alma-Ata, adapted four key strategies for attaining health for all. One of these key strategies was promoting healthy lifestyles and reducing risk factors to human health that arise from environmental, economic, social and behavioural causes. If the agenda has remained unfinished by a wide margin, the primary reason could be found in our failure to develop an enabling policy for promoting a hygienic environment conducive to healthful living. Environmental services such as community water supply, sanitation, control of air and water pollution, waste disposal and personal and domestic hygiene along with nutrition and health education are central to the concept of preventive and social medicine, and they are the key pillars of primary health care.

Access to safe water is now a basic human right, as per the resolution of the 29th Session of the UN Committee on Economic, Social and Cultural Rights, November 2002. To protect human health and to prevent sickness and mortality, community water supply needs to be reliable, in sufficient quantity, of adequate quality and readily accessible to all segments of the consumers. The people in the developed countries are mostly having the privilege and opportunity of having adequate quantity of water of acceptable quality, anytime and anywhere in the country. The same is not true for the citizens of most third-world countries like India, particularly the poor. Water scarcity, surface and ground water contamination and lack of access to safe drinking water by the poor are among the main obstacles to full enjoyment of the right to water in our country. The health outcome of the lack of sanitation and safe water is enormous, globally 4 billion cases of diarrhoea, 2.2 million deaths per annum and 62.5 million disability-adjusted life years (DALYS) lost. The World Bank estimates that 99.9% of deaths attributed to poor water supply, sanitation and hygiene occur in the developing countries. An estimated 60–80% of all diseases and over 1/3 of deaths in the developing countries are caused by environment-related factors, and on an average as much as 1/10 of each person's productive time is sacrificed to environment-related diseases.

Following the Alma-Ata and Mardel del Plata conference, the International Drinking Water Supply and Sanitation Decade was launched in India with high hopes and expectations for supplying safe and potable water to most of our population in the 1980s. Unfortunately, the decade has been for all practical purposes a story of misplaced priority, lost opportunity and unfinished agenda. It is time for a

serious introspection to identify the maladies and plan for the future. The scientific and technical leaders of the country as well as the policymakers in the national government owe it to the community to explain our failures during all these years since independence. It is also extremely urgent that a blueprint and a road map for providing safe, clean and affordable water to all segments of our community living in urban, peri-urban and rural areas need to be drawn up, particularly in the context of the new programmes and initiatives being launched by the national government.

It is in the above context that NASI organized the 1st Policy Support Brainstorming on “Safe Water for Rural and Urban India” in Allahabad, July 2009, in collaboration with WHO and SISSO. It was a highly successful event, attended by the leading scientists, engineers and sector leaders of the country. At the end of the two-day brainstorming, the Allahabad Declaration was adopted, along with a set of concrete recommendations. As a follow-up, a number of R&D proposals were also formulated and submitted to the Department of Science and Technology, GOI.

I would be failing in my duties if I don't mention the total support, advice and guidance that I received from the late Dr. V.P. Sharma, the joint editor of this book, all through the three brainstorming programmes on safe water and sanitation. Dr. Sharma, who was an internationally acclaimed entomologist, vector control expert and malariologist, had been a great source of inspiration and guidance for me during the last four decades. We worked together in the WHO global team for the in-depth evaluation of the Indian malaria control programme in 1985, and ever since then he had been a friend, philosopher and guide for me. It was his concern for environmental issues including sanitation, waste management and provision of safe water that stimulated the idea of the 1st Brainstorming. But for the committed support and leadership of Dr. Sharma, the successful organization of the three policy support brainstorming programmes would not have been possible. His untimely death has been a great loss for the scientific community of the country and a personal shock for me. I am sure that the president, NASI and council members along with the fellows and members would join me in dedicating this book to the memory of Dr. V.P. Sharma.

Dr. Sharma and I deliberated at length regarding the continuing crisis in the drinking water and environmental sanitation sector in the country and decided to organize the 2nd Brainstorming in 2012. The 2nd Policy Support Brainstorming on “Safe Water and Sanitation in the New Millennium” was organized by NASI in collaboration with SISSO in Allahabad, September 2012. As in the 1st Brainstorming, the leading scientists, technocrats and sector leaders participated, and a number of papers dealing with important technical and policy issues were presented. At the end of the brainstorming, a set of recommendations were formulated which was submitted to key government departments and important R&D and HRD

organizations. However, it was felt and Dr. Sharma strongly endorsed the idea that the papers presented in the conference contained important scientific, technical and policy issues which would be extremely valuable for the scientists and professionals of the country, and as such we agreed, and it was proposed to the NASI Council that a book containing these papers should be published. The proposal was approved by the NASI Council, and the internationally reputed publishing house Springer Nature has been entrusted with the publication of the book.

The book contains 20 chapters including the introductory overview of the country situation by the undersigned in Chap. 1. Chapter 2 deals with the present status of rural water supply in the country in the context of the current initiatives by the government. The sanitation scenario along with the flagship programmes including problems, prospects and key constraints is elaborately discussed in Chaps. 3 and 4. The concept of water safety plan, as visualized by WHO, and the guidelines for its applicability for the rural water supply projects in the country are discussed in Chap. 5. Various kinds of technologies applicable for the rural communities and the risk and safety requirement associated with the same, are thoroughly discussed in Chap. 6 including issues related to household point-of-use treatment and its health significance along with consumer safety. The geogenic and anthropogenic contamination of groundwater with arsenic, fluoride, pesticides, heavy metals, etc. and its impact on community health are elaborately discussed in Chaps. 7, 8 and 9. Issues related to arsenic-related technologies and case studies for community-based approach for the same are discussed in Chaps. 10 and 11. Urban wastewater management with particular reference to sewer rehabilitation and maintenance is discussed with elaborate illustrations in Chap. 12. The critical issues of urban solid waste management and the challenges posed by the same for the municipal managers are analysed and discussed in Chap. 13. The bioenvironmental control of vectors and the need for an integrated and eco-based approach are presented in Chaps. 14 and 15. The impact of bacteriological and chemical contamination of drinking water on the health and nutritional status of the community is highlighted in Chaps. 16 and 17. The sustainable management of water resources in India is discussed with particular reference to the feasibility of linking the rivers in Chap. 18. A most interesting case study on the cost-benefit analysis of production of hydropower from the river is critically discussed in Chap. 19. In Chap. 20, the author discusses a novel Gandhian model of development based on non-violent culture.

Kolkata, India

K.J. Nath

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## About the Editors



**Prof. K.J. Nath**, BE (Cal), MEPH (Cal), DSE (Delft), FIE, FNASc, FIPHE, FIWWA, FNESA is widely regarded as one of India's foremost experts on Sanitation and Community Water Supply, Environmental Health and Public Health Engineering. As Professor of Environmental Sanitation and Director of the All India Institute of Hygiene & Public Health (AIHH&PH), Govt. of India (GOI), he did seminal works on rural and urban sanitation and water supply, urban waste management, air and water pollution, water quality surveillance, environmental epidemiology and impact assessment. His expertise has been requisitioned by several National & International Organizations including the Planning Commission, Council of Scientific & Industrial Research (CSIR), Indian Council of Medical Research Institutes (ICMR). Ministries

of Environment, Health, Urban Development, and Rural Development of the Govt. of India as well as State Govts. & Local and Development agencies, Research Academic Institutes. At the International level, he has served on a number of occasions as a consultant and Member/Chairman of expert panels of the World Bank, Asian Development Bank, WHO, UNICEF, UNEP, UNDP, WSSCC, UN-Habitat, International Scientific Forum on Home Hygiene (IFH), U.K, U.S Trade Development Agency etc. He served as a Member of Steering Committee/Working Group of the Planning Commission from the sixth 5 Year Plan to 10th 5 Year Plan. He was a Member of the Planning Commission High Power Committees on SWM and Public Health (1997–1998), Steering Committees of the 1st and 2nd Phase Ganga Action Plan, Expert Member of NGRBA (2009–2014), National Task Force on Environmental Health, Chairman of the National Co-ordination Council on Water Quality, Rajiv Gandhi Drinking Water Mission. Presently he is the **Chairman, Arsenic Task Force, West Bengal; Chairman, Core Committee on Water Quality, Safety & Security, Govt. of West Bengal and Member, Scientific Advisory Board and SEA Regional Coordinator, International Scientific Forum on Home Hygiene (IFH), UK, Member of the Technology Advisory Group, WHO (Climate Resilient WASH), President of Institution of Public Health Engineers, India (IPHE)**, the premier national professional association of the Public Health Engineers in India. He has published more than 150 research and review papers, books, monographs etc. He has received several awards including Rajiv Gandhi Memorial Sulabh Sanitation Award (1998), Environmental Scientist of the Country award by National Environmental Science Academy (1999), Golden Jubilee award of the Indian Public Health Association (2007), Most Eminent Public Health Engineer of the Country by Institute of Engineers in 2008. **He is a fellow of the National Academy of Sciences, India; Indian of Public Health Association; Institution of Public Health Engineers, India; Institute of Engineers; Indian Water Works Association and he is an Honorary Fellow of the National Environmental Science Academy, India and Member, International Water Academy, Oslo.** Prof. Nath has to his credit, more than 150 publications of books, monographs, course manuals, etc. and papers presented in International and National Conferences and published in reputed International and National Journals.



**Dr. Vinod Prakash Sharma**, MSc (1960), DPhil (1964), DSc (1979), all from Allahabad University, is postdoctoral research associate of the University of Notre Dame and Purdue University, USA (1964–1968); pool officer of the Forest Research Institute, Dehradun (1969–1970); senior scientist of WHO/ICMR Research Unit on the Genetic Control of Mosquitoes, New Delhi (1970–1975); deputy director of Vector Control Research Centre/Malaria Research Centre (1975–1982); founder director of the National Institute of Malaria Research (1962–1998); and additional director general of the Indian Council of Medical Research (1998). He is FNA, FASc, FNASc, FAMS, FTWAS and fellow of several other learned societies. He has specialized in malaria and vector biology. He has 40 years of research and field experience, published 400 scientific papers and book on *Anopheles* and edited 14 books. Under his leadership, NIMR had earned international reputation of excellence in malaria research and control and

established linkages with leading national and international laboratories. He conceptualized the bioenvironmental malaria control strategy as an alternative to spraying and successfully demonstrated malaria control in various eco-epidemiological settings. Dr. Sharma's work has become legendary. As a result of his indefatigable efforts, today we have technologies to fight malaria which are safe and cost-effective, produce sustainable impact and are free from environmental hazards produced by DDT and other insecticides. His work has been recognized nationally and internationally. He was invited to work on various WHO panels since 1980s. He was chair of the WHO/UNEP/FAO Panel of Experts on Environmental Management (PEEM) for Vector Control (two 5-year terms). WHO invited him to write/review GFATM proposals for SEA Regional countries, i.e. Indonesia, Timor Leste, Myanmar, Bhutan, Bangladesh and India, and for Sierra Leone by the NGO BRAC. He was the principal architect for writing World Bank and other projects for the Indian programme on malaria control. He chaired review committees of the NMEP, Nepal, Bhutan and Thailand, and is actively involved in the evaluation of countries capabilities to proceed towards malaria elimination. He was invited in WHO (Geneva and New Delhi) meetings as temporary adviser. He represented India on the Scientific Committee on the Problems of the Environment (SCOPE), Paris, for nearly 20 years and later was elected as executive member of the SCOPE. In that capacity he coordinated the "Health and Environment" cluster of the SCOPE. He was president of the National Academy of Sciences, India (1999–2000); Indian Society for Parasitology (1993–1997); and National Academy of Vector and Vector Borne Diseases (1979–2008); chief editor of the *Journal of Parasitic Diseases* and *Indian Journal of Malariology*; council member of the International Congress of Entomology, UK (two terms); and member of the WHO Expert Committee on Malaria, Geneva, still continuing. He is a recipient of several national and international awards/honours, e.g. WHO Darling Foundation Prize (1999); ICMR Ambedkar and MOT Iyengar awards; Lifetime Achievement Award; Green Scientist Award; G.P. Chatterjee Memorial Award; Ranbaxy award; FICCI award; Om Prakash Bhasin Award; Vasvik awards; distinguished parasitologist recognition by the World Federation of Parasitologists (2010); Gujar Mal Modi Award (2013); Vigyan Vibhuti award by the Utrakhand State Council for Science and Technology (2013); Meghnad Saha Distinguished Fellow (2005–2010); NASI Distinguished Professor and ICMR Chair in Public Health Research (2010–2015) at the Indian Institute of Technology, New Delhi; and Padma Shri (1992) and Padma Bhushan (2014) awarded by the President of India.