Preface

It is estimated that over 1.1 billion people do not have access to safe water (UNICEF Handbook on Water Quality, 2008). Clearly, this creates enormous human health and welfare challenges. The reasons for the unavailability of safe water relates to the enormous capital investment and operating expenses that must be incurred to be able to provide reliable and safe water; this is simply out of reach for most developing countries. This book was written to provide insight into the available sustainable technologies for producing an adequate safe water supply.

In many regions of the world, including the United States, rivers carry significant amounts of pollutants derived from industrial and municipal discharges, nonpoint sources such as agricultural and urban runoff, and accidental spillage. Water utilities that use surface water for supply must remove these chemicals in the plant prior to distribution. This involves the use of significant amounts of chemicals and advanced treatment technologies such as activated carbon or membrane units if micropollutants (e.g., pesticides, gasoline and solvent constituents) are present in the source waters. These technologies are expensive and they also need highly skilled operators.

Many small communities, even in industrialized countries, do not have such resources to meet the challenges. For long-term sustainability, incorporation of the most advanced technologies may not be feasible for small communities in developed countries and for most communities in developing countries. To respond to this crucial need, appropriate technologies are discussed in the book.

Water treatment methods such as solar distillation, solar pasteurization, membrane filtration utilizing techniques and materials that are affordable, and natural soil/aquifer filtration may be considered sustainable. These systems can function effectively at various scales and be able to provide potable water with very little need for additional treatment. Also, these technologies can be affordable in developing countries.

Solar distillation has been practiced in many arid and desert countries. In certain places, solar stills are coupled with membrane units for drinking water production. There are several variations of the stills used for drinking water production. One of the recent versions, patented by the US Department of Interior (inventor: J. Constantz), can be used for drip irrigating row crops and producing drinking water.

Solar pasteurization is one of the easiest methods to produce potable water in remote sunny areas. Heating water to a sufficiently high temperature for a certain time period destroys harmful microorganisms. It is also an inexpensive alternative in areas without electricity and water infrastructures. Common materials such as cylindrical plastic bottles can be used to pasteurize water by exposing the water to sunlight. A simple but effective method, with the tradeoff of low flow-rates.

Currently, membrane filtration is an expensive treatment technology and it is used for the desalination of sea water, brackish water, or other process waters. Depending on the pore sizes of the membranes, they are classified as "microfiltration," "ultrafiltration," "nanofiltration," and "reverse osmosis." Membrane cost and energy needed to pressurize the water chamber above the membranes control the per unit production cost of water. It is still possible to produce membrane filtrate from low-cost materials using alternate energy sources so that the process can be "democratized."

Natural filtration is a process that utilizes the pollutant adsorption and degradation capability of soil and aquifer materials and it has been formally deployed for drinking water production in Europe for more than a century. Wells, either vertical or horizontal, are placed some distance away from the river and are pumped on a sustained basis. This induces the river water to flow to the pumping wells. During soil and aquifer passage most contaminants from surface water are removed via sorption or degraded through microbial processes.

Biblical stories mention drinking water from a hole next to the Nile River rather than drinking the water from the river directly. In most areas of the developing world, especially in rural communities, the spread of cholera diminished after the use of hand pumps compared to the situation when surface water was used for drinking. Therefore, the soils and the underlying aquifer materials have tremendous capacity to remove surface water pollutants.

If properly designed and operated, most natural filtration systems (called bank filtration systems) do not need significant additional treatment with the exception of disinfection. However, excessive pumpage using infiltration galleries or scouring of riverbeds may reduce the effectiveness of such systems. In all instances, the quality of filtrate from these systems is still superior to that of the river water.

Provided in the book is a comparative analysis of drinking water treatment technologies that focus on appropriate technology and sustainability (Chap. 2). This chapter can serve as a means of comparing various sustainable treatment technologies for potential implementation. Some of the key technologies discussed are: *natural filtration, riverbank filtration, slow sand filtration, membrane filtration, solar pasteurization, membrane desalinization, and solar distillation.*

The chapter on transdisciplinary analysis provides information about sustainability concepts, industrial practices, sustainability of technology in developing countries, sustainability framework, and suggestions for technology transfer and implementation.

It is desirable to use less amounts of chemicals, energy, and manpower in drinking water production. Greater sustainability is achieved when comparable quality

of water is produced without the need of excessive amounts of energy, labor, and expensive equipment/technology.

Some of the sustainability strategies that need to be examined in detail are: (a) reduction in chemical and energy use in water treatment, (b) production of water that contains less pathogens and disinfection byproducts compared to the use of surface water, and (c) focus on water utilities and communities (e.g., water treatment plants) to improve source water quality to reduce further treatment of the filtrate. If the watersheds are protected and the source water is of high quality, treatment technologies can be less costly and thus sustainable.

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University of Hawaii, Honolulu — Chittaranjan Ray
University of the Pacific, California — Ravi Jain

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