

Arid Lands Water Evaluation and Management

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Preface

Arid and semi-arid lands constitute about 30% of the Earth's land environment. The need to develop new freshwater sources in these water-short areas is rapidly increasing because of both population and economic growth. Many of these arid lands are dependent to a large degree on non-renewable resources that are slowly being mined with no real plans to replace them in the future. Therefore, considerable attention must be placed on the integrated management of existing and new water resources that will supply future potable, agricultural, industrial demands. Within the concept of sustainability, the maintenance of the natural system also must be considered and commonly, when it is ignored, negatively impacts primary water supply sources and food security.

This book is an integrated approach to evaluation and management of water resources in arid lands. Methods and management practices applied to arid lands are commonly unique to these stressed regions and principles applied to humid or semi-humid regions cannot necessarily be applied to arid or semi-arid lands. Many arid regions, such as the Middle East and parts of Africa and South Asia, require the integration of technical solution approaches with fundamental economic and sociocultural challenges. Natural system generated water supplies cannot meet future demands in most cases, therefore, the development of new water sources, such as desalination of brackish-water and seawater and increased reuse of wastewater are required.

This book is not solely a technical monograph that provides methods to evaluate primarily groundwater systems in arid lands, but contains a holistic approach to water management in arid lands. Water supply development must contain a degree of economic realism with the sophistication matching the abilities of the water users and operators to be able to pay for and manage the infrastructure. In the past decades large errors have been made in arid lands water management, wherein well-meaning investors and non-governmental organizations have funded and constructed water and wastewater supply and treatment systems that cannot be operated or paid for by the end users. For example, some poorly designed dams have aided one part of a basin and devastated another part of it; mega-groundwater supply projects have been developed that resulted in land subsidence, high

evapotranspiration losses, and loss of arable land; sophisticated, high-technology wastewater plants have been constructed that lie unused because the economy and educational levels do not allow for them to be operated and maintained; and environmental “restoration” projects have been developed to reforest farmlands with an unexpected impact of lowering aquifer water levels by several meters, causing reductions in local food production from the remaining farmlands.

We believe that much can be learned for the past practices used to sustain people in arid lands where management of the localized water resources was paramount to survival. While localized water harvesting techniques cannot produce the vast quantities of water needed to supply large cities using centralized systems, they can provide needed water for the hundreds of thousands of small villages and farms that occur throughout the arid lands of the world. The wise capture and storage of temporally rare rainfall events was the key to survival in the past and may also be so in the future.

Economic, sociocultural, and policy issues are often of greater importance in water management than technical issues. The best science and engineering in water resources management is of little value if it does not get incorporated into actual water management practices and projects. We have endeavored to objectively present basic concepts, with the understanding that men and women of good will may have different perspectives, values, and beliefs. Any opinions expressed are solely those of the authors.

Arid lands will face considerable challenges in the future as the Earth’s climate warms and causes more extreme periods of drought with longer duration and also, the extreme storm events will become more common, resulting in the need to create storage using a variety of techniques including dams and reservoirs, aquifer recharge and recovery of surface and impaired waters, and a variety of smaller-scale artificial recharge projects. Large water deficits will occur in arid regions supplied by rivers and streams dependent on seasonal glacier-melt flows as these vast ice reservoirs melt in response to warmer temperatures. The issue of global climate challenge will force management of water in arid lands to become fully integrated using all available existing sources, the development of new sources (desalination and water reuse), and the expansion of storage types. New methods of controlling water demand will be needed, such as the development of new food production methods, such as crop production using saline water on genetically-engineered crops and growing food crops in graint, climate controlled greenhouses.

The assessment and management of water resources in arid and semi-arid lands is a dynamic field of research. A positive frustration in preparing this manuscript has been that after we “completed” a chapter, a new paper would later be published that includes valuable information and insights that required further revision of the chapter. Indeed, it is impossible to write a definitive text on any dynamic field as science is constantly progressing.

The intended users of this book should include university students studying engineering, hydrogeology, economics, and environmental restoration; planners that need to understand fundamental water management principles and how they apply to arid lands; practicing design engineers involved in surface-water

management, water treatment design, wastewater treatment plant design, and the integration of multiple water treatment supply and distribution systems; and most of all government officials and elected leaders that need to guide the decision-making process into practical pathways based on fundamental economic principles with the needs of the people and environment being considered at every step of the development and implementation process. Many subjects covered in chapters or sections of this text could be comprehensive books by themselves. Therefore, the information presented is a general summary of the general concepts and principles involved and available the techniques to evaluate and manage water resources. Extensive references are provided to provide a greater depth of understanding and examples of the diversity of approaches that have been taken to evaluate arid lands. The focus of this book is largely on groundwater resources, because in most arid and semi-arid lands surface water resources are limited and already fully utilized. Surface water, particularly in ephemeral systems, is critical as the source of groundwater recharge. Groundwater quality issues, particularly contamination, are of increasing importance, but merit a dedicated book in itself to adequately address.

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