

Introduction to Water Resources and Environmental Issues

How much water does the world need to support increasing human populations? What factors influence water quality, droughts, floods, and water-borne diseases? What are the potential effects of climate change on the world's water resources?

These questions, and more, are discussed in this thorough introduction to the complex world of water resources for undergraduate students. The strength of this book is its coverage of science fundamentals of water, aquatic ecology, geomorphology, and hydrology. Topics are brought to life for students from all areas of science with the use of internet sources and water resource issues in the news.

The book begins with a short history of human use of and influence on water. The basics of water chemistry and the hydrologic cycle are discussed in detail, with chapters on the geomorphology, hydrology, chemistry, and biology of lakes, rivers, and wetlands. Major disease issues, worldwide water quality and quantity problems, and potential solutions are also addressed. Water laws, water allocation, and inherent conflicts are discussed using international and US examples.

Students of biology, environmental science, environmental studies, life science, chemistry, earth science, watershed science, and engineering will benefit from this broad survey of crucial water issues.

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Preface

Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less. **Marie Curie (1867–1934)**

Water gives life to our Earth, but creates fear when there are shortages during a drought, or too much in a flood. Increasing world population and industrialization have led to another fear – water too polluted to use. We see thousands of acres (hectares) devastated by drought around the world; food shortages in regions of Africa; and devastating droughts in Asia, Australia, Canada, Europe, and the US. Livestock, crops, and humans suffer. Simultaneously, China's Yellow River has become so polluted that its waters are not usable for drinking. Water-borne diseases still kill millions of people – especially the young. No country – industrialized or less-developed – is immune to water problems.

Understanding the natural cycle of water, water's properties, the role of water ecosystems, and the consequences of human change is essential to minimizing the damaging effects of drought, flood, pollution, and human efforts to use and manage water resources. Decisions that impact our environment are made by governments made up of people in all fields of study. Unfortunately, policy-makers understand our natural world in varying degrees of expertise – from almost nothing to excellent. The results of poorly informed decisions can be disastrous for humans and the Earth.

We believe that all citizens should have a fundamental knowledge of water on our planet. Too often, students avoid science classes because they are perceived as some combination of hard, confusing, boring, or irrelevant to their daily lives. We decided to write this book to make the subject of water, water resources, and water's interactions in the environment understandable, approachable, and relevant to a wide range of students. We hope we have succeeded.

Our goal is to present a balanced look at water use and water requirements – both by humans and the rest of our environment – to provide the basic understanding necessary for future leaders to make informed decisions. For example, suppose a major dam project is being proposed in your region. If someone considers that damming a river can create water quality impacts because of reduced cleansing flows, measures can often be built into the project to protect water quality. These measures may not necessarily be related to the dam itself, but to the entire watershed. Making connections – understanding that unintended consequences often occur, and calling in the experts before a project begins – is a tremendous improvement in project planning.

One textbook cannot adequately cover all the subjects necessary to understand our water environment. Therefore, this text deals primarily with freshwater systems and provides a background aimed at encouraging students to explore water resources issues further. It is also intended to expose students to the wide range of water resources from many viewpoints including biology, chemistry, geology, history, hydrology, law, limnology, medicine, and soil science.

- The text examines water from global and historical perspectives – with its roles today and in the development of civilizations.
- The text moves into various areas of science, with the hydrologic cycle, water chemistry, and water quality providing the fundamentals. Subjects that require more understanding are presented as *In Depth* sections. These are intended to interest the more curious student.
- The concepts of ecosystems are explored in chapters on watersheds, groundwater, lakes and ponds, rivers and streams, and wetlands. Sidebars and guest essays provide additional information and case studies.
- Human attempts to control natural systems are explored through the study of dams and structures. The importance of dams and reservoirs is considered as well as their consequences.
- The chapter on drinking water explores attempts to repair and restore damaged systems. Natural sources of pollution, as well as human-produced pollution, are discussed. Water-borne diseases and the complexities of their control are considered.
- Water law and water allocation are discussed. Who gets to control water is a tremendously controversial subject, and includes competing needs and uses by cities, industry, individuals, and the environment. Depleting groundwater or drying up a river is akin to killing the goose that laid the golden eggs.
- The roles of governments, and the various agencies they create, are presented primarily using the United States as an example. Case studies demonstrate positive and negative interactions of agencies all trying to do their jobs while competing for tax dollars.
- The final chapter summarizes the state of our Earth's water resources and encourages students to think about the future of water and humans as inseparable features. A final look at major issues – from global climate change to competing personal values – shows how much more there is to learn and the complexity of decisions that are still to be made.