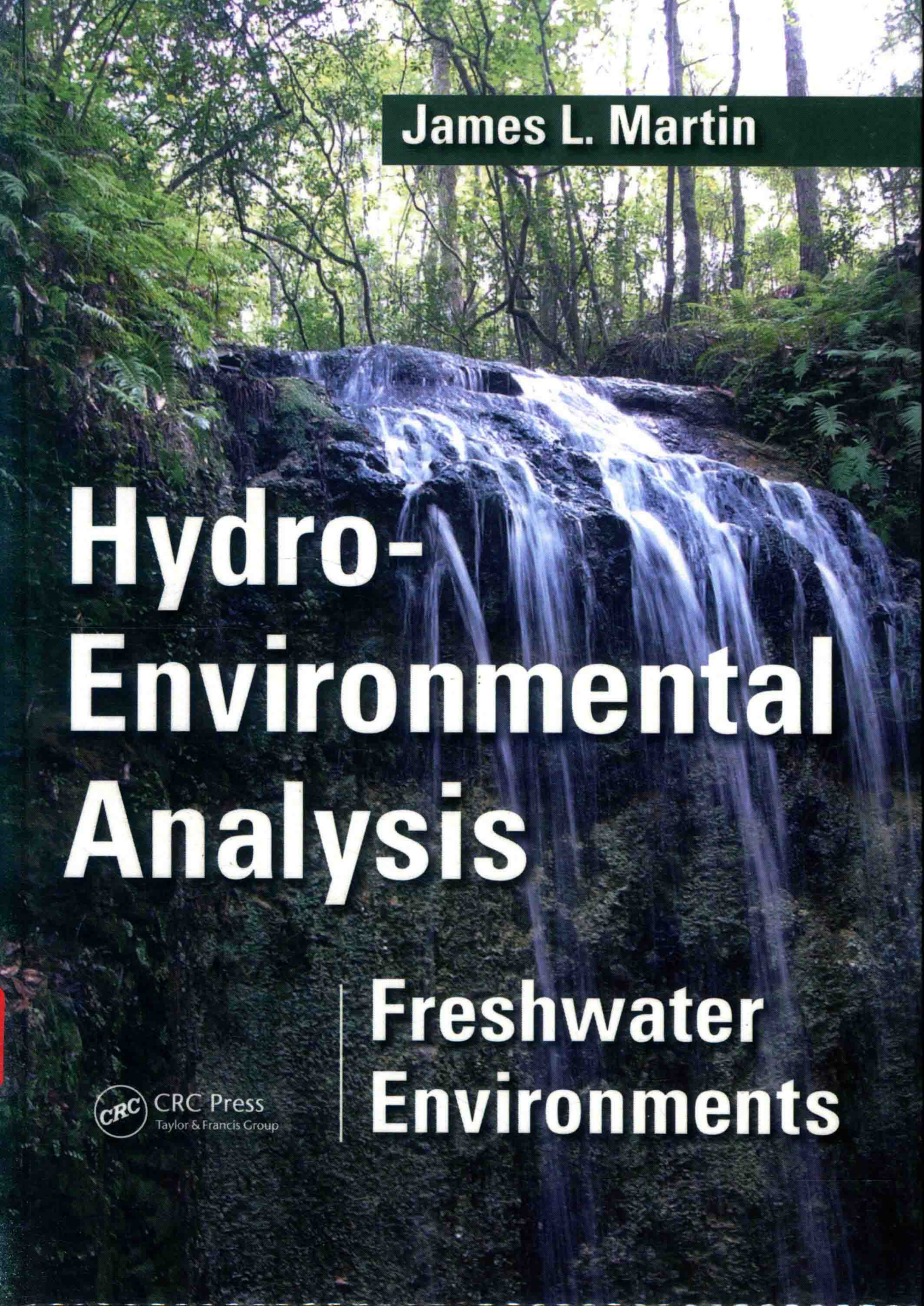

James L. Martin

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Freshwater Environments

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Hydro-Environmental Analysis

Freshwater Environments

Dedication

To my family for their love and support, and
to my students for whom this is written

Preface

Adequate supplies of water are a crucial resource for any human activity. The water resource management paradigm, as implemented in both practice and law, for much of our history focused on the management of fresh waterbodies, such as rivers and streams, lakes and reservoirs, to meet the supply needs of water for human use for drinking, recreation, navigation, and often just for conveying wastes. Equally important has been the management of those systems for excess water, either to prevent or control flooding or to remove excess water to convert lands for some human benefit. It has only been in recent decades that there has been a paradigm shift such that consideration of environmental needs is now a required component of all water resource projects. The Clean Water Act (CWA) in 1972 set a new national goal "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Many environmental resource and engineering activities today are focused on either the maintenance of environmental quality in, or remediating historical damage and restoration of, our aquatic systems.

Factors impacting the chemical, physical, and biological integrity of our nation's waters are extremely complex and factors affecting those processes and their interactions are often poorly understood. That makes water resource management extremely interesting and also a challenge, for example, determining how and what waterbodies should be restored "to" (per the CWA) and ensuring that this generation's solution does not become the next generation's problem.

This book was developed in part for a graduate course of the same name that the author teaches at Mississippi State University. The course is offered by the Department of Civil and Environmental Engineering, but students populating the course are typically from a wide variety of academic disciplines, both in science and in engineering. That course is intended to introduce the physical, chemical, and biological characteristics of rivers and streams, lakes and reservoirs, estuaries and coastal waters from an engineering perspective. This volume will focus on freshwater environments.

The "design" audience of the book is environmental and water resource engineers and environmental scientists. The book is not a traditional engineering book in that it concentrates on broad and general concepts, rather than specific design criteria. By design, there are few equations in this book and the format is relatively informal. Rather, the book focuses on an introduction to the characteristics of freshwater environments as those characteristics may affect, or be affected by, water resource management and engineering projects. The book is intended to introduce students of environmental science to engineered structures and students of engineering to the aquatic and limnological sciences. The book focuses on regulated freshwater environments, as there are relatively few waterbodies that are not controlled or modified to some degree. Because of the complexity of these aquatic systems, often precise definitions and classification become difficult. However, these definitions and systems of classification are important for a variety of reasons, such as for scientific study, for the survey of these systems and how they change with time, and for regulation such as under the CWA. Often it is the legal or regulatory definition that controls the management of these systems, so this book focuses in part on those regulatory definitions. Finally, the book will introduce some of the basic considerations and principles involved in the restoration or management of aquatic systems.

This volume (freshwater environments) is divided into two parts: Rivers and Streams, and Lakes and Reservoirs. Each part begins by discussing the characteristics of those systems and methods of classification, followed by a discussion of physical, chemical, and biological characteristics. In the section on lakes and reservoirs, the characteristics and operations of regulatory structures are also introduced. Methods commonly used to assess the environmental health or integrity of these waterbodies are then presented, followed by an introduction to considerations for restoration.

The last two chapters deal with an introduction to two unique aquatic environments: wetlands and reservoir tailwaters.

I gratefully acknowledge all of the contributions of my students and colleagues that have helped shape this book. I particularly thank Sandra L. Ortega-Achury for her contributions, advice, help, and the correction of many of my blunders. I also would like to thank my wife for her patience and support. Finally, I would like to thank my major advisor for my PhD, Dr. Steven C. Chapra, who many years ago provided me not only an education but also a profession and a philosophy to live by: "Do what you love, and love what you do, and you'll never work again."

James Lenial Martin

Author

James Lenial Martin is professor and Kelly Gene Cook, Sr. chair in civil engineering in the Department of Civil and Environmental Engineering at Mississippi State University. Previously, he was a research environmental scientist with the U.S. Environmental Protection Agency at its Large Lakes Research Station, a research civil engineer with the U.S. Army Corps of Engineers Waterways Experiment Station, and vice president and director of engineering with AScI Corporation. His degrees include a bachelor of science in wildlife science from Texas A&M, a bachelor of science in civil engineering from Texas A&M, a master of science in biology from Southwest Texas State University, and a PhD in Civil and Environmental Engineering from Texas A&M. He is a registered professional engineer in Mississippi, a founding diplomate in water resources engineering with the American Academy of Water Resources Engineers, and a fellow of the American Society of Civil Engineers. He has over 30 years of experience conducting and managing water quality modeling projects and developing and applying models of hydrodynamics and water quality. He is senior author of *Hydrodynamics and Transport for Water Quality Modeling* and senior editor and author of *Energy Production and Reservoir Water Quality* and has authored/coauthored over 100 technical reports and publications, including Environmental Protection Agency guidance documents and model user documentation.

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