

Mackenzie L. Davis Susan J. Masten

Principles of Environmental Engineering and Science

(Second Edition)

环境科学与工程原理 (第2版)



大学环境教育丛书

(影印版)

Mackenzie L. Davis Susan J. Masten

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Engineering and Science**

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出版前言

在 21 世纪之初,面临各种环境问题,人类清醒地认识到要走可持续发展之路。而发展环境教育是解决环境问题和实施可持续发展战略的根本。高等学校的环境教育,是提高新世纪建设者的环境意识,并向社会输送环境保护专门人才的重要途径。为了反映国外环境类教材的最新内容和编写风格,同时也为了提高学生阅读专业文献和获取信息的能力,我们精选了国外一些优秀的环境类教材,加以影印或翻译,组成大学环境教育丛书。所选教材均在国外被广泛采用,多数已再版,书中不仅介绍了有关概念、原理及技术方法,给出了丰富的数据,也反映了作者不同的学术观点。

我们希望这套丛书的出版能对高等院校师生和广大科技人员有所帮助,并为我国的环境教育事业作出贡献。

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2008 年 10 月

Preface

Following the format of the first edition, the second edition of *Principles of Environmental Engineering and Science* is designed for use in an introductory sophomore-level engineering course. The book covers the basic, traditional subject matter that forms the foundation of more advanced courses. As such, it provides the fundamental science and engineering principles that instructors in more advanced courses may assume are common knowledge for an advanced undergraduate. In our offerings of this course, we have found that mature college students in allied fields—such as biology, chemistry, resource development, fisheries and wildlife, microbiology, and soils science—have no difficulty with the material.

We have assumed the students using this text have had courses in chemistry, physics, and biology as well as sufficient mathematics to understand the concepts of differentiation and integration. Basic environmental chemistry and biology concepts are introduced at the beginning of the book. In the mathematical presentations, we have provided only a few derivations. In our experience, the more rigorous approach of derived mathematics may yield a result that is not more but less demonstrative—and even confusing—to the beginning engineering student.

A major theme carried through the text is mass balance. Chapter 4 is an introduction to the concept of materials and energy balance as a tool for understanding environmental processes and solving environmental engineering problems. It is then applied in the hydrology, sustainability, water quality, water and wastewater treatment, air pollution, and solid and hazardous waste chapters.

Each chapter concludes with a list of review items, the traditional end-of-chapter problems, and, perhaps less traditional, discussion questions. The review items have been written in the “objective” format of the Accreditation Board for Engineering and Technology (ABET). Instructors will find this particularly helpful for directing student review for exams, for assessing continuous quality improvement for ABET, and for preparing documentation for ABET curriculum review. We have found the discussion questions useful as a “minute check” or spot quiz item to see if the students understand concepts as well as number crunching.

The second edition has been thoroughly revised and updated. With the addition of 73 new end-of-chapter problems, there are now a total of 395 problems. The following paragraphs summarize the major changes in this edition.

- Eleven case studies have been added to introduce material in appropriate chapters.
- A discussion of the history of environmental engineering and environmental science is now included in the first chapter. The discussion of laws and regulations has been replaced by a brief discussion of the process by which laws and regulations are developed.
- A new, stand-alone chapter on biology has been added (Chapter 3).
- All the example problems and end-of-chapter problems on risk assessment have been revised to incorporate new estimates of intake and slope factors.
- A quantitative introduction to well drawdown has been added to the hydrology chapter (Chapter 7).
- The chapter on resources (Chapter 8) has been completely revised and slimmed down. Its focus is on sustainability. A discussion of biofuels and hydrogen fuel for automobiles is included.
- The water quality management chapter (Chapter 9) has been revised with updated material on arsenic, nanoparticles, and endocrine disruptors.

- The water treatment chapter (Chapter 10) has been revised to include new material on membrane filtration and AOPs.
- A new introduction, a new section on treatment standards, and a new section on membrane treatment have been added to the wastewater chapter (Chapter 11).
- The air pollution standards have been updated and new material on mercury, lead, and $PM_{2.5}$ has been added to the air pollution chapter (Chapter 12). In addition, the sections on origin and fate, indoor air, acid rain, ozone depletion, global warming, and control of automobile emissions have been updated.
- The solid waste chapter discussion of collection methods has been updated to include collection of compostable material (Chapter 13).
- In the hazardous waste chapter, a new section and example problem, on pump and treat, has been added (Chapter 14).
- A revised introduction to the noise pollution chapter (Chapter 15) includes the impact of hearing loss on people, as well as the economic impact of noise pollution on civil engineering projects and businesses. A new discussion of the L_{dn} concept and a revision of the method of calculating airborne transmission of noise are included.
- The ionizing radiation chapter has three new example problems and an updated discussion of radioactive waste management (Chapter 16).

Online Resources

An instructor's manual and set of PowerPoint slides are available online at www.mhhe.com/davismasten for qualified instructors. Please inquire with your McGraw-Hill representative for the necessary access password. The instructor's manual includes sample course outlines, solved example exams, and detailed solutions to the end-of-chapter problems. In addition, there are suggestions for using the pedagogic aids in the next.

As always, we appreciate any comments, suggestions, corrections, and contributions for future revisions.

Mackenzie L. Davis
Susan J. Masten

Acknowledgments

As with any other text, the number of individuals who have made it possible far exceeds those whose names grace the cover. At the hazard of leaving someone out, we would like to explicitly thank the following individuals for their contribution.

The following students helped to solve problems, proofread text, prepare illustrations, raise embarrassing questions, and generally make sure that other students could understand it: Shelley Agarwal, Stephanie Albert, Deb Allen, Mark Bishop, Aimee Bolen, Kristen Brandt, Jeff Brown, Amber Buhl, Nicole Chernoby, Rebecca Cline, Linda Clowater, Shauna Cohen, John Cooley, Ted Coyer, Marcia Curran, Talia Dodak, Kimberly Doherty, Bobbie Dougherty, Lisa Egleston, Karen Ellis, Craig Fricke, Elizabeth Fry, Beverly Hinds, Edith Hooten, Brad Hoos, Kathy Hulley, Geneva Hulslander, Lisa Huntington, Angela Ilieff, Melissa Knapp, Alison Leach, Gary Lefko, Lynelle Marolf, Lisa McClanahan, Tim McNamara, Becky Mursch, Cheryl Oliver, Kyle Paulson, Marisa Patterson, Lynnette Payne, Jim Peters, Kristie Piner, Christine Pomeroy, Susan Quiring, Erica Rayner, Bob Reynolds, Laurene Rhyne, Sandra Risley, Carlos Sanlley, Lee Sawatzki, Stephanie Smith, Mary Stewart, Rick Wirsing, Ya-yun Wu. To them a hearty thank you!

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A special thanks to Mack's wife, Elaine, for putting up with the nonsense of book writing.

Mackenzie L. Davis

Susan J. Masten

About the Authors

Mackenzie L. Davis is an Emeritus Professor of Environmental Engineering at Michigan State University. He received all his degrees from the University of Illinois. From 1968 to 1971, he served as a Captain in the U.S. Army Medical Service Corps. During his military service, he conducted air pollution surveys at Army ammunition plants. From 1971 to 1973, he was Branch Chief of the Environmental Engineering Branch at the U.S. Army Construction Engineering Research Laboratory. His responsibilities included supervision of research on air, noise, and water pollution control and solid waste management for Army facilities. In 1973, he joined the faculty at Michigan State University. He has taught and conducted research in the areas of air pollution control and hazardous waste management.

In 1987 and 1989–1992, under an intergovernmental personnel assignment with the Office of Solid Waste of the U.S. Environmental Protection Agency, Dr. Davis performed technology assessments of treatment methods used to demonstrate the regulatory requirements for the land disposal restrictions (“land ban”) promulgated under the Hazardous and Solid Waste Amendments.

Dr. Davis is a member of American Chemical Society, American Institute of Chemical Engineers, American Society for Engineering Education, American Meteorological Society, American Society of Civil Engineers, American Water Works Association, Air & Waste Management Association, Association of Environmental Engineering and Science Professors, and the Water Environment Federation.

His honors and awards include the State-of-the-Art Award from the ASCE, Chapter Honor Member of Chi Epsilon, Sigma Xi, election as a Fellow in the Air & Waste Management Association, and election as a Diplomate in the American Academy of Environmental Engineers with certification in hazardous waste management. He has received teaching awards from the American Society of Civil Engineers Student Chapter, Michigan State University College of Engineering, North Central Section of the American Society for Engineering Education, Great Lakes Region of Chi Epsilon, and the Amoco Corporation. In 1998, he received the Lyman A. Ripperton Award for distinguished achievement as an educator from the Air & Waste Management Association. In 2007, he received the Professional Educator of the Year award from the Michigan Water Environment Association. He is a registered professional engineer in Michigan.

In 2003, Dr. Davis retired from Michigan State University.

Susan J. Masten is a Professor in the Department of Civil and Environmental Engineering at Michigan State University. She is also a Professor and Director of the Level One Program at McMaster University, Hamilton, ON. She received her Ph.D. in environmental engineering from Harvard University in 1986. She worked for several years in environmental research before joining the MSU faculty in 1989, including at the US Environmental Protection Agency Kerr Laboratory, in Ada, Oklahoma. Professor Masten’s research involves the use of chemical oxidants for the remediation of soils, water, and wastewater. Her research is presently focused on the use of ozone for reducing the concentration of disinfection by-products in drinking water, controlling fouling in membranes, and reducing the toxicity of ozonation by-products formed from the ozonation of polycyclic aromatic hydrocarbons and pesticides. She also had research projects involving the use of ozone for the reduction of odor in swine manure slurry and the elimination of chlorinated hydrocarbons and semivolatile organic chemicals from soils using in-situ ozone stripping and ozone sparging.

Dr. Masten is a member of the following professional organizations: American Chemical Society, International Ozone Association, American Water Works Association and the American Society for Engineering Education. She served the Executive Committee of the MSU Chapter of the American Chemical Society from 1995–2005.

Professor Masten was a Lilly Teaching Fellow during the 1994–1995 academic year. She is also the recipient of the Withrow Distinguished Scholar Award, College of Engineering, MSU, March 1995, and the Teacher-Scholar Award, Michigan State University, February 1996. Dr. Masten was also a member of the Faculty Writing Project, Michigan State University, May 1996. In 2001, she was awarded the Association of Environmental Engineering and Science Professors/Wiley Interscience Outstanding Educator Award.

Dr. Masten is a registered professional engineer in the state of Michigan.

About the Cover Artist

Barbara Masten, sister of Susan Masten, attended art school before completing an associate degree in nursing in 1983. Barbara is employed as the lead floor nurse in a New Jersey nursing home but in her spare time, she is able to continue her beloved career in art.

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