

VOLUME 2: M-Z

ENCYCLOPEDIA OF
ENVIRONMENTAL
SCIENCE AND
ENGINEERING
SIXTH EDITION

EDITED BY
Edward N. Ziegler



 CRC Press
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Thou ever-darting Globe! through Space and Air!
Thou waters that encompass us!
Thou that in all the life and death of us, in action or in sleep!
Thou laws invisible that permeate them and all,
Thou that in all, and over all, and through and under all, incessant!
Thou! thou! the vital, universal, giant force resistless, sleepless, calm,
Holding Humanity as in thy open hand, as some ephemeral toy,
How ill to e'er forget thee!
One thought ever at the fore—
That in the Divine Ship, the World, breasting Time and Space,
All Peoples of the globe together sail, sail the same voyage, are bound to the same destination.

—Walt Whitman (ca. 1890)

Foreword

The editors were honored to have had the foreword to the first five editions written by the eminent thinker and renowned environmental engineer the late Dr. Abel Wolman. His insights through the decades proved to be accurate, and his overview is shared in this sixth edition as an inspiration to innovators in the coming decades and in memory of his distinguished contributions to the environmental field.

The 1980s appear in a world dominated by change at an unprecedented pace. Familiar and new problems tumble over each other and are communicated globally by the second, instead of by the month. Scientific and technologic choices are spawned day by day, while search for innovation is stimulated anew by government, universities, and private industry.

Practitioners are startled by these events and try to keep apace with society's demands by pressing for relevant research, implementation of findings, and translating their significance to the public they serve. It is within this challenging setting that a sixth edition of the *Encyclopedia of Environmental Science and Engineering* is born. Its content is intended to register the striking characteristics of the changes we note to eliminate the already obsolete and to expose the new on the horizon.

In the turbulence of the 1960s and 1970s, policies, plans, solutions, and regulations flowed without interruption from

legislative and executive halls. The 1980s might appropriately be devoted to postaudit stock-taking and reorientation of both policy and action. Clarification of purpose in confrontation of the problems of the environment is overdue. Validation of our efforts over the last two decades should provide an arena of productivity for science and engineering to guide us through the coming decades.

As manpower and money are always in short supply, even in so-called rich countries, they must be husbanded. How to use them with maximum competence and logic, minimum risk, and least cost is a continuing obligation in the protection and control of the biosphere.

We must extricate ourselves from adversarial combat in a world of negativism and move to an orderly identification of what we know and away from the hysterical search for a doubtful Utopia. The authors in this sixth edition continue the pursuit of new knowledge, calculated to bring new fruits of health, safety, and comfort to man and his environs. The charms, as well as the subtle hazards, of the terms *conservation*, *preservation*, and *ecology* need to be crystallized so that the public and their decision-makers practice this complex art with clearer conception and perception than is apparent in recent bitter confrontations.

Abel Wolman

Preface

In the editors' preface to the fifth edition it was noted that there was good news and there was bad news. It is the same for this, the sixth edition. One suspects that this will always be the case.

The 2004 Nobel Prize for Peace was awarded to Professor Dr. Wangari Maathai. Dr. Maathai's award was based on her efforts on behalf of conservation and women's rights. These efforts were made at great personal risk.

In addition, the Kyoto Protocol has been ratified by the requisite number of countries. The bad news is that some developed nations have declined to join this global effort. It is to be hoped that, in time, these countries will change their policies.

Protection of the environment is an ongoing struggle, and it is incumbent on all citizens of the planet to join in protecting the only home that we have.

Acknowledgments

The editor would like to express his gratitude to Dr. James R. Pfafflin for his contributions, without which the *Encyclopedia of Environmental Science and Engineering* would never have seen fruition. In the 40 or so years since Jim first invited me to join this endeavor, I have come to know him as a dedicated teacher and friend who has helped and inspired countless

people to enter the environmental field. He was one of the original proponents of the view that protection of the environment is an international rather than a parochial effort, a concept that is faithfully carried forth in the current work. Jim, I would like to thank you for being my mentor and for sharing your wisdom and fine sense of humor.

Editor

Edward N. Ziegler is an associate professor of chemical and biological engineering at Polytechnic Institute of New York University and former director of its Environmental Science Program. Dr. Ziegler, a Distinguished Teacher Award recipient, teaches graduate courses, one in air pollution engineering control and another in chemical reactor analysis, in addition to undergraduate chemical engineering courses. He earned his BS in ChE from CUNY (City University of New York)

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