

SECOND EDITION

JAY LEMERY · KIM KNOWLTON · CECILIA SORENSEN

EDITORS

GLOBAL CLIMATE CHANGE AND HUMAN HEALTH



FROM SCIENCE TO PRACTICE



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Second Edition

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JL: In loving memory of two of the world's most formidable mentors: Dean Jack Blackburn and Mr. Jim Westhall. Here's some evidence that you are indeed still changing the world!

KK: With love and gratitude to my parents, Stewart Knowlton and Nadine Wolfe, for their kindness and encouraging hours of scientific discovery under the big willow tree; and to my loving husband, Allen, for his patience and for asking the best questions.

CS: To future generations—may you enjoy the beauty of this wondrous planet.

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PREFACE

Recently, we took a field trip with a group of public health and medical students to the National Science Foundation Ice Core Facility in Lakewood, Colorado. The students were taking one of the nation's first medical school courses in climate change and health, and it was time to get out of the classroom to see science in action. We weren't quite sure what to expect as, essentially, we were going to visit a warehouse full of ancient ice.

It was May, but we were told to bring our deep winter gear—down jackets, hats, and gloves. The room was built for Arctic winter, set at 40° below, the singular temperature where Fahrenheit is the same as Celsius. After a short film explaining the process of ice core science, we were introduced to the star of the show: there, in all its cryogenic glory, a recumbent ice tube containing the atmospheric carbon record of the last several thousand years. The staff was masterful in recounting a science narrative explaining how the project was conceived, data obtained, and conclusions rendered.

The students were mesmerized. We witnessed a cascade of “ah-ha!” moments, the Holy Grail for any educator where the abstract notions, numbers, and equations all come together in a spark of enlightenment for the learner. For us, that day was more than a lesson in science, it was a lesson in the power of science communication—our highest aspiration as we bring you the most up-to-date expert climate and health science in this second edition.

Much has changed since we published our first edition in 2015.

We can be thankful that the science of climate change has advanced remarkably, while simultaneously, economically viable green technologies have emerged at an unprecedented rate. Despite public acceptance around climate science globally, we've seen a backlash against science-backed climate policy and intransigence toward policy action, especially in the United States. Understanding public opinion and perceptions around climate change and science, which can shape or hinder smart policy, has become a science unto itself, and we explore that in this book.

New challenges have emerged that are rewriting climate narratives. We now must incorporate the profound impact of the recent pandemic into our work and understand how they are related. Do the public health remedies for both coincide? Although we have yet to fully digest this experience, what is clear is that COVID-19 shows us how fragile our interconnections are and how rapidly we can mobilize resources—both human action and financial resources—to address a common threat. It also offers a palpable admonishment of our custodianship of the commons and the limitations of current governance—both national and international—to implement policy. Yet there is no doubt the COVID-19 crisis presents an opportunity for us to upgrade our operating system, to think about public health resilience, energy policy, and global governance.

Despite the rapidly changing events, the goal of this textbook remains the same: to serve as a resource for public health and clinical medicine practitioners, students, and learners. We crafted this book to be a comprehensive source on climate and health issues, authored by the experts who demonstrate mastery of the many complex facets of this topic. We added innovative pedagogical elements, expanded clinical correlations from the first edition, led each chapter with key concepts; included a glossary, and are again supporting educators with materials

in the form of electronic teaching slides with accompanying multiple choice and essay questions.

New to this second edition are updates to the core climate and health science topics, issues of health equity, novel perspectives from clinical medicine and allied health professions, and an expansive discussion on the dizzying aspects of global governance. We have likewise recruited experts to share science on the unique vulnerabilities that women suffer from climate change as well as the interrelated topics of ecosystem services and loss of biodiversity.

It is our sober assessment that when it comes to protecting our health from climate change, we are not keeping pace. It's easy to look at the table of contents and feel pessimistic. Yet there is much for which to be hopeful. Since the publication of our last edition, medical societies have banded together in action and joined thousands of public entities in divesting from fossil fuels, major medical journals have prioritized climate-related topics, graduate schools of public health and medicine have launched dedicated climate and health curricula, and energetic grassroots student groups have emerged across campuses. Perhaps most telling is that public opinions are slowly changing.

One thing is certain: the science will advance, and in that regard, we feel fortunate to have this platform to share with you. May our next edition reflect the health implications from shifts in grassroots perceptions, the maturation of clean technologies in the marketplace, and the efficacy of smart policies enacted.

We believe this is the grand health challenge of our times. For us, there is no better outlet for our intellectual and creative energies than to present the work of our accomplished authors to you.

Jay Lemery
Kim Knowlton
Cecilia Sorensen

FOREWORD: CLIMATE CHANGE AND THE PANDEMIC

Craig Spencer

My career in medicine and public health has brought me to sub-Saharan Africa and southeast Asia, as well as the American southwest. I've responded to outbreaks of hepatitis E in Chad, Ebola in West Africa, and most recently on the frontlines of coronavirus disease 2019 (COVID-19) in New York City.

Despite being different outbreaks in different places, the one constant similarity in all was how public health crises always disproportionately affect already marginalized and vulnerable communities.

For a long time, we've known that we were susceptible to a global pandemic. In recent decades, outbreaks of SARS (severe acute respiratory syndrome coronavirus 2) and MERS (Middle East respiratory syndrome) alerted us to the possible implications of global spread. The 2014–2016 West Africa Ebola outbreak further highlighted how a public health threat anywhere represents a threat everywhere. In the aftermath of all of these outbreaks, lessons learned documents formed the basis for adaptations and change. Yet despite all this, when COVID-19 rapidly spread around the world in 2020, we found ourselves unprepared.

Along with the recent rise of nationalism and antimigrant rhetoric, there has been increasing critique of the globalist mindset—this idea that the people and nations of the world are inextricably linked. As countries have gradually receded and focused inward, they've taken apart and undermined much of the preparedness done to prevent and respond to a global public health threat.

The Social Injustice of the Pandemic

In that sense, it's not the COVID-19 pandemic that was surprising. It's how poorly we managed it. Throughout history, epidemics arise on the margins of our society, the disease taking root among the most vulnerable. It was Virchow who noted that *medicine is a social science and politics is nothing else but medicine on a large scale* (Virchow 1985). The mortality rate from COVID-19 is highest among the elderly, communities of color, and those with preexisting health conditions and is likely to be devastating for the poorest and in the developing world.

Climate Justice

Unfortunately, we know this is a harbinger of things to come. The pandemic experience foreshadows the health impacts from climate change, compounding every year with extreme weather patterns, sea level rise, food and water insecurity, and many other drivers articulated in this textbook. As the authors consistently point out in each of these chapters, it's the most marginalized and vulnerable who will suffer the most—through geography, age, socioeconomic status, and medical comorbidities. The public health policy response to the COVID-19 pandemic has pitted individual rights against collective action. I am too sanguine to think that apolitical unity would be a default societal response in these times; however, we do have powerful tools to lead and to continue to shape the policy narrative.

We can lead on the incredible successes of data-driven public health responses. Even before John Snow's eureka moment at the Broad Street pump, the world has benefited from global health initiatives proven to be a sound investment. No better example exists than the global campaign against smallpox, which was finally eradicated in 1980. Smallpox had long been humanity's greatest scourge. In the late 1700s, smallpox was so feared that even the first president of the United States—George Washington, himself a smallpox survivor—described it as a “greater threat than . . . the Sword of the Enemy.” For the unparalleled commitment to smallpox eradication, the United States saves the total of all its historic contributions to ending smallpox every 26 days because it does not have to vaccinate or treat the disease (Center for Global Development n.d.).

The worldwide response to the HIV/AIDS pandemic recognized that supporting global health initiatives not only has a humanitarian impact. PEPFAR (President's Emergency Plan for AIDS Relief) was established in 2003 by President George W. Bush to increase access to HIV/AIDS treatment around the world. Since its inception, this program has greatly reduced HIV/AIDS-related morbidity and mortality by providing treatment to millions of men, women, and children worldwide. Subsequently, we have also seen the profound strategic national and international benefits by preventing social unrest and political instability in the countries most affected by HIV/AIDS in the developing world.

To date, many in the developed world have equated emergency preparedness with individual preparedness. But none of us has the individual ability to affect our sick neighbors' risk of disease spread or to roll out widespread testing for evidence of infection. Collective action is a precondition for managing any public health crisis, be it from a pandemic or global environmental change—and these actions are not necessarily rooted in protecting the individual as much as protecting the most vulnerable in our communities.

Leading

Yet because the pandemic has upended many of our assumptions—not only about public health but also governance, economic models, and social policies—you readers have an unprecedented opportunity to lead on this issue. And the rhetoric you choose does not have to be steeped in dour consequences—we have a lot to be excited about and to give the public a positive reason for change. We can lead on solutions.

Technology is giving us better ways tools to decarbonize while reducing the cost of energy. *Wright's law*—a model that predicts plummeting costs as new technology comes to scale—has proven true for wind, solar, and battery power. In many instances these technologies are now cheaper than oil and gas, ushering a future of cheap and abundant clean energy. As we think about how to reinvigorate our economy from the pandemic, such opportunities afford us a synergistic benefit in both job creation for a growing market and reduced greenhouse gas emissions.

The reputation of science has taken some bruising in recent years. But when it comes to illness or injury, everyone wants the best science working for themselves and their loved ones. Therein lies our ability to affect public risk assessment and to advance an evidence-based approach toward risk and opportunity.

I conclude by sharing with you a moment from my time on the frontlines of Ebola in West Africa. I had seen so many succumb to this disease and I felt like I hadn't made a difference. Yet one day, while being treated for Ebola myself in a hospital in New York City, I received a call from someone far away. She heard I was sick and called to thank me for caring for her family and to wish me well. I recognized then that I had indeed made an impact. Because over and over she thanked me. She believed if I hadn't been there to take care of her and her family none of them would have survived this disease.

In caring for others I had created a community of people across the world who cared about me because I had cared about them.

If we are to successfully tackle the public health and climate challenges in coming years, we will need collective action. Action based on creating a worldwide community that cares about others. If the COVID-19 pandemic taught us anything, it's that in times of global crisis we need global solidarity.

This book is a framework for the actions and decisions we need to foster this global community of caring. But it is only by operationalizing our voices, our advocacy, and our passion that we will create the collective response necessary to confront the public health and climate crises that undoubtedly lie in front of us.

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Jay Lemery, MD, is professor of emergency medicine at the University of Colorado School of Medicine, chief of the Section of Wilderness and Environmental Medicine, and professor in the Department of Environmental and Occupational Health at the Colorado School of Public Health. He is a past-president of the Wilderness Medical Society.

In 2015 Dr. Lemery coedited the first edition of *Global Climate Change and Human Health: From Science to Practice*, and in 2017 he coauthored *Enviromedics: The Impact of Climate Change on Human Health*. He was a technical contributor to the *Fourth National Climate Assessment* (2018) produced by thirteen federal agencies, and from 2011 to 2016, he was a consultant for the Climate and Health Program at the Centers for Disease Control and Prevention.

Dr. Lemery graduated as an Echols Scholar from the University of Virginia and has a medical degree from the Geisel School of Medicine at Dartmouth. He also holds academic appointments at the Harvard School of Public Health (FXB Center), where he is a contributing editor for its journal, *Health and Human Rights*. Dr. Lemery sits on the National Academy of Medicine's Roundtable on Environmental Health Sciences, Research, and Medicine and is currently the medical director for the National Science Foundation's Polar Research program.

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Kim Knowlton, DrPH, MS, is assistant professor of environmental health sciences at the Mailman School of Public Health, Columbia University; and past chair of the Climate Change Topic Committee of the American Public Health Association's Environment Section. She served as co-convening lead author for the human health chapter of the U.S. Third National Climate Assessment; as a member of the 2nd and the 4th New York City Panel on Climate Change and participated in the Intergovernmental Panel on Climate Change's 2007 Fourth and 2013 Fifth Assessment Reports. She is a health scientist specializing in the human health impacts of climate change, particularly air pollution and extreme heat.

Her work with the New York Climate and Health Project 2001–2007 described some of the first downscaled global-to-regional climate-air quality/heat-health effect modeling results in the United States and served as a foundation for her collaboration with climate, atmospheric chemistry, and land use modelers. She also serves as senior scientist and deputy director of the Science Center at the Natural Resources Defense Council in New York, where she works to help communities in the United States and partners in India adapt to our changed climate, connect the dots between climate and health for multiple audiences, and put science in the service of advocacy to protect people and the planet.

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Cecilia Sorensen, MD, is an emergency medicine physician-investigator in the area of climate change and health at the University of Colorado School of Medicine and the Colorado School of Public Health. Following residency training at Denver Health in Denver, Colorado, she

became the inaugural Living Closer Foundation Fellow in Climate and Health Science Policy, based at the University of Colorado School of Medicine and the National Institute of Environmental Health Sciences.

Dr. Sorensen has a broad range of expertise at the intersection of human health, environmental health, and social justice. Her recent work has spanned domestic as well as international emergent health issues related to climate change, including heat stress and worker health in Guatemala, wildfires and health care utilization in the United States, the emergence of Zika virus in Ecuador following the earthquake of 2016, climate change and women's health in India, and mortality following hurricane Maria in Puerto Rico.

Translating this research into policy to order to build resilience in vulnerable communities is the focus of her work. To this end, she has served as a health author for the U.S. Fourth National Climate Assessment and serves as a technical advisor for the annual Lancet Climate and Health U.S. Policy Brief. Additionally, she is a founding member of the Colorado Chapter of Physicians for Social Responsibility, a member of the Colorado Consortium for Climate Change, a scientific advisor for the Citizens Climate Lobby and the course director for the nation's first medical school course on climate change and human health.

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