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Understanding Sea-Level Rise and Variability

Edited by John A. Church, Philip L. Woodworth, Thorkild Aarup, and W. Stanley Wilson, Wiley-Blackwell, 2010, 427 pages, ISBN 9781444334517

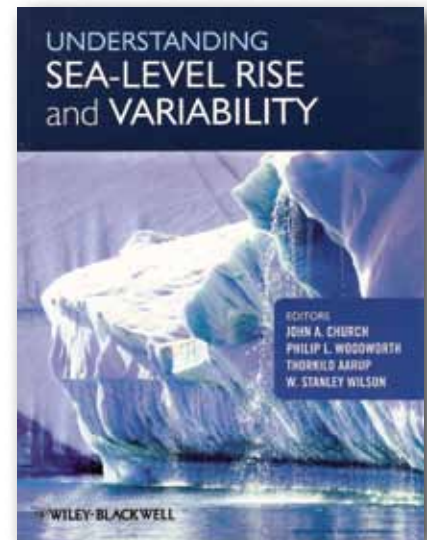
REVIEWED BY BENJAMIN P. HORTON

Global sea level rise is one of the more certain impacts of human-induced global warming, although future projections of its magnitude vary widely. Given the large and growing population and economic activity in the coastal zone, as well as the importance of its ecosystems, the potential impacts of sea level rise have elicited widespread concern. To understand sea level change, we must know the sum of global, regional, and local trends related to changing ocean and land levels. Indeed, coastal managers are concerned about the interplay among global sea level rise, regional and local subsidence, and variations in sediment supply, as these determine the impacts at the coast and form the basis of management response plans. The impending threat of sea level rise to large, low-lying coastal cities such as New Orleans, Shanghai, and Venice, and island communities such as Maldives, Kiribati, and Tuvalu, highlights the importance of understanding all these factors. To address these issues, the World Climate Research Programme (WCRP) organized a workshop in June 2006, which led to the publication of this book.

Understanding Sea-Level Rise and Variability aims to identify the major impacts of sea level rise, present up-to-date assessments of past and present sea

level change, explore all of the contributing factors, and investigate extreme sea level events. The book manages to achieve these notable aims by bringing together an excellent array of authors. Its 11 chapters address the current level of understanding of sea level change and make recommendations for reducing the uncertainties so that more reliable future sea level projections can be made. These concepts are introduced in Chapter 1 and synthesized in Chapter 13.

Chapters 2 (“Impacts of and Responses to Sea-Level Rise” by Robert J. Nicholls) and 3 (“A First-Order Assessment of the Impact of Long-Term Trends in Extreme Sea Levels on Offshore Structures and Coastal Refineries” by Ralph Rayner and Bev MacKenzie) discuss the varied impacts of sea level rise. Extreme events such as Typhoon Morakot, Hurricane Katrina, and Cyclone Nargis demonstrated that a growing population is vulnerable to coastal flooding associated with sea level rise and extreme events. Importantly, these two chapters put the research described in subsequent chapters into a broader context. Chapters 4 and 5 dovetail to provide a concise understanding of past and present sea level changes. Chapter 4 (“Paleoenvironmental Records, Geophysical Modeling, and Reconstruction of Sea-Level Trends and Variability on Centennial and Longer Timescales” by Kurt Lambeck and co-authors) emphasizes the importance of past sea level changes on millennial to centennial time scales



that are revealed in geological and archaeological data. The chapter begins by explaining that sea level is far from a constant, planar surface, but rather exhibits spatial and temporal changes at a multitude of scales. It considers both local (e.g., seismic events, compaction of coastal sediments, loss of coastal sediment supplies) and regional components of sea level change. Chapter 5 (“Modern Sea-Level-Change Estimates” by Gary T. Mitchum and co-authors) reviews notable recent advances regarding the collection of accurate observational sea level data, including geological proxies from salt marsh sediment and instrumental records such as tide gauges and satellite altimetry. The authors illustrate how these advances enabled a better understanding of the spatial and temporal patterns in sea level during the nineteenth and twentieth centuries.

The next three chapters discuss the contributions to sea level rise from the ocean, cryosphere, and land. The sixth chapter (“Ocean Temperature and Salinity Contributions to Global

and Regional Sea-Level Change” by John A. Church and co-authors) focuses specifically on trends in sea level due to thermal expansion and density changes. The chapter separates thermosteric and halosteric contributions to sea level regionally and globally and expertly reviews a range of methods and models that determine sea level change as related to total steric change. This chapter serves as an excellent summary of the recent advances in sea level rise research. Chapter 7 (“Cryospheric Contributions to Sea-Level Rise and Variability” by Konrad Steffen and co-authors) provides an excellent source of information regarding the current knowledge of changes in the cryosphere and the main uncertainties. Not straightforward, this field of research is constrained by many factors, such as the large number and variety of glaciers. The chapter reviews many of the detailed requirements for an improved understanding of the cryosphere via modeling of dynamics of ice flow, altimetry, and space gravity measurements. Chapter 8 (“Terrestrial Water-Storage Contributions to Sea-Level Rise and Variability” by P.C.D. “Chris” Milly and co-authors) describes how changes in terrestrial water storage (i.e., ice sheets, glaciers, snow pack, and surface and subsurface water) are usually directly related to changes in ocean water volume. The authors explain that the many uncertainties associated with estimating terrestrial water storage and its relationship to climatic and anthropogenic factors (e.g., dam building, irrigation schemes, and the mining of ground water) are attributed to the lack of understanding of the interconnections between surface

and subsurface water storage. This chapter discusses the significant progress made in gathering hydrological information from three methods: in situ observations, satellite techniques (including GRACE, the Gravity Recovery and Climate Experiment), and land storage models.

Chapters 9 and 10 highlight the importance of geodetic techniques (in situ and space-based observations) for studies of sea level change and its contributing factors. Chapter 9 (“Geodetic Observations and Global Reference Frame Contributions to Understanding Sea-Level Rise and Variability” by Geoff Blewitt and co-authors) introduces the spectacular progress of space-based observations in the last decade. Gravitational measurements of Earth have now refined to 10 nm s^{-2} accuracies with the advent of the GRACE and Gravity field and steady-state Ocean Circulation Explorer (GOCE) missions. Terrestrial position and altitude measurements now have accuracies greater than 1 mm using Global Positioning Systems (GPS), and interferometric synthetic aperture radar (InSAR) can now track changes in ice sheet volume and density over multiple flyovers through time. From this information, Earth’s International Terrestrial Reference System (ITRS) was created to provide a vital globally accepted reference frame. Chapter 10 (“Surface Mass Loading on a Dynamic Earth: Complexity and Contamination in the Geodetic Analysis of Global Sea-Level Trends” by Jerry X. Mitrovica and co-authors) is concerned with the complex process of how the solid mass of Earth responds to past and

present changes in surface mass load. The chapter discusses the reservations that exist regarding models of past ice sheets and the physics of glacial isostatic adjustment as well as the implications for these models to provide suitable corrections to tide gauge and altimeter sea level data. The authors also introduce the concept of sea level fingerprinting, which will enable development of regional predictions of sea level based on meltwater source.

Chapter 11 (“Past and Future Changes in Extreme Sea Levels and Waves” by Jason A. Lowe and co-authors) discusses the evidence for changes in extreme sea levels such as storm surges, waves, and mid-latitude and tropical storms. The chapter discusses the limitations involved in modeling these processes and points to the importance of considering interactions between the factors that contribute to extreme sea level. It provides detailed regional case studies (e.g., Bangladesh) and introduces the essential Global Sea Level Observing System (GLOSS) and the Global Climate Observing System (GCOS). Chapter 12 (“Observing Systems Needed to Address Sea-Level Rise and Variability” by W. Stanley Wilson and co-authors) describes the international consensus on the observational requirements needed to improve monitoring systems, and it summarizes existing systems that must be sustained, new systems to be developed, and the terrestrial reference frame that is central to all existing and new systems.

Understanding Sea-Level Rise and Variability condenses a vast amount of information into one book, including appropriate discussion of historical sea level change as well as the factors

contributing to modern sea level rise. The chapters cover the difficulties in modeling and quantitatively explaining observed twentieth-century sea level rise. The book deals with how sea level rise will affect society and even provides recommendations for climate change

mitigation and suggestions for planning adaptations to reduce the impacts. The editors suggest that the book is intended to complement the Intergovernmental Panel on Climate Change (IPCC) scientific assessments—it does much more than that!

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Escape from the Ivory Tower: A Guide to Making Your Science Matter

By Nancy Baron, Island Press, 2010,
240 pages, ISBN 978-1597266642,
\$27.50 US (softcover)

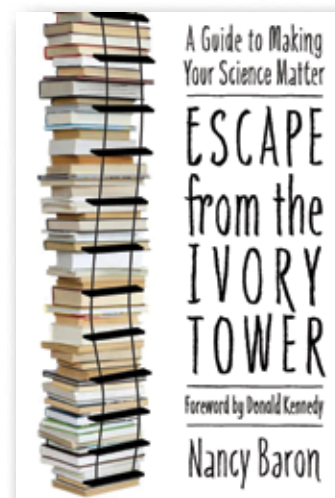
REVIEWED BY JONATHAN H. SHARP

Nancy Baron, the communications specialist for COMPASS (the Communication Partnership for Science and the Sea), wrote the book reviewed here, giving it the subtitle of “A guide to making your science matter.” The last two words in the subtitle are critical and were also used in a special evening panel at the 2008 Ocean Sciences meeting—there, our subtitle was “does science really matter?” We, as environmental scientists, can be dedicated to our research and teaching, and be passionate about their importance to society. But, maybe our science *does not really matter* unless we can communicate our findings and their importance to the general public and decision makers.

Baron is a trainer of scientists, teaching them how to communicate with the public, both at COMPASS and through the Leopold Leadership Program. She cites the activities of

some of our scientific peers who have successfully communicated information about critical environmental problems to the public on a national level. She has worked with many of them as well as the better-known environmental journalists. Her book has interesting personal anecdotes and stories about established research scientists who have made the leap from the “ivory tower” to public communication. It also has advice from some of the environmental journalists.

Following an introductory discussion about scientists deciding to speak out, Baron provides a section about the differences between the cultures of research scientists and journalists and policymakers. It is very important for any scientist who wants to effectively bring the results of his/her work to the attention of the public to understand these cultures’ differences. Too often, we forget that most of the rest of the population does not have our scientific backgrounds, and thus is starting from a different perspective in understanding our work. Early in the book, Baron says: “If you decide you want to inform



those outside your research arena, and help guide public discourse, you will need to learn a new set of skills. These include knowing exactly what you want to say, understanding your audience, and using common language to get your main point across.”

The author’s third part offers several chapters as a “how-to tool kit.” They address how to deliver a clear message as well as how to prepare to be interviewed by a journalist, and they explain the differences in message delivery between print, radio, and television. Baron also addresses the idea of the scientist reaching out rather than waiting for a request from the media. I will discuss separately the subjects of the scientist