Flooding and Management of Large Fluvial Lowlands

Large fluvial lowlands are among Earth's most unique and productive environments but are being rapidly degraded by human activities. Pressure on large rivers and deltas has increased tremendously over past decades because of flood control, urbanization, and increased dependence for agriculture and food production. This book examines human impacts on lowland rivers and discusses how these changes affect different types of riverine environments and flood processes, and how these "lessons" can be used to more sustainably manage large rivers and deltas. Surveying a global range of large rivers, including the Mekong, Nile, Sacramento, Danube, Huanghe, among others, the book especially examines management of the Rhine River in the Netherlands and the lower Mississippi in Louisiana. A particular focus of the book is on sedimentology and hydraulic engineering, which is described in a straightforward writing style accessible to a broad audience of researchers, practitioners, and advanced students in physical geography, fluvial geomorphology and sedimentology, and flood and river management.

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A Global Environmental Perspective

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To Mom and Dad, to my family,
voor Marie-Louise.

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Preface and Acknowledgments

The importance of writing a book about the geomorphic and environmental impacts of hydraulic engineering to lowland rivers has long seemed obvious. I've mainly studied and resided in lowland coastal plain settings, other than an early stint in the Midwest having been born in Wisconsin. This includes north Florida and the lower St. Johns River valley, the Holocene Mississippi floodplain in Baton Rouge, Louisiana, and Austin, Texas at the upper fringe of the Gulf Coastal Plain. And now, atop late-Holocene sand dunes at the terminus of the Rhine delta in the Netherlands.

Since the early 1990s I've conducted research on the theme of human impacts to lowland rivers, particularly topics related to hydraulic engineering and flooding. The concept for the book really began to take shape over a decade ago after my return to Austin from Utrecht in late summer 2008. At Utrecht we focused on an explicit comparison of management approaches between the Mississippi and Rhine, a timely theme given the 2005 flooding of New Orleans and new developments in flood management in the Netherlands. Colleagues in the Department of Geography and the Environment at UT Austin encouraged me to embark on the sinuous journey of writing a monograph. I was keen. Well, life is rich – and complex – and in 2010 it involved relocating to the Netherlands and two universities that resulted in a series of start and stop attempts to write the book. A semester research sabbatical from Leiden University College in autumn 2015 finally provided the watershed moment to hunker down and tackle the book, although I didn't realize it would take another six years.

In some ways this work is a historical treatise in that it draws upon prominent themes and topics of where I've studied, taught, and researched. I was fortunate to complete my doctorate at Louisiana State University (LSU), immersed in the rich tradition of scholarship on fluvial–deltaic processes and engineering geomorphology of the lower Mississippi River prominently developed by R. J. Russell and H. N. Fisk, among others. At LSU my doctoral supervisor, R. H. Kesel, embraced these themes and also emphasized the importance of archival and historic research as complementary and essential to scholarship in geomorphology. This is necessary when working on large rivers and can be particularly rewarding when working on rivers that have long been utilized for human settlement. And I became acquainted with several themes herein examined during my MSc thesis work at the University of Florida with Joann Mossa, who also completed her doctorate at LSU. Joann introduced me to the lower Mississippi during a "Friends of the Pleistocene" field trip (actually focused on the Red River valley) in Louisiana. With repeated trips between Baton Rouge and Vicksburg along Scenic Highway (U.S. 61), I became fully ensconced in the lore of the lower Mississippi alluvial valley. And many trips to New Orleans, that great sinking delta city, provided a unique perspective on the difficulty of flood management in a complex urban environment undergoing high rates of ground subsidence. At LSU I had courses and attended lectures by esteemed scholars, including H. H. Roberts, J. M. Coleman, G. W. Stone, among others, that oozed of Mississippi delta science.

I've been fortunate to have an academic career over the past twenty-five years that enabled me to conduct research and annually teach courses closely aligned with themes contained herein, including at the University of Texas at Austin, and in the Netherlands at the University of Amsterdam and Leiden University. At UT Austin, I had great scholars as colleagues, including Karl Butzer, who was always supportive and instilled a measured perspective on current fluvial disasters that can only be appreciated when working across longer timescales ("we've seen this before..."). Receipt of a US Fulbright Fellowship spent in residence (2007–2008) with Hans Middelkoop's group at the Institute of Physical Geography at Utrecht University was invaluable for shedding light on several themes herein reviewed, and for gaining an appreciation for the high level of scholarship in geomorphology and the precision to which flood management science is practiced in the Netherlands. I've also been fortunate to have great students who enquire about topics we might have thought were worked out but were not, thereby unwittingly helping to elucidate gaps in knowledge and stimulate new research ideas. Teaching and research really are bidirectional.

It's important to acknowledge that this treatise could not have been written without the tremendous body of scholarly materials

from which it draws. This includes materials produced by government agencies in the form of reports and data sets invaluable to academic research. I'm particularly grateful for a range of materials provided by the U.S. Army Corps of Engineers (esp. Potamology Program) and Rijkswaterstaat. Additionally, digital archives and databases from a wide range of organizations were important for providing historic photographs, imagery, maps, and data. These especially included Actueel Hoogtebestand Nederland (lidar DEM), American Rivers, Bangkok Metropolitan Agency, Bank Swallow Technical Advisory Committee (California), Australian National Committee on Large Dams, DamRemoval.eu, Delfland Water Authority, Delta Regional Authority (Mississippi), German Federal Waterways and Shipping Administration, Google Earth Pro, International Commission on Large Dams, International Commission for the Protection of the Danube, International Commission for the Protection of the Rhine, Louisiana Coastal Protection and Restoration Authority, Louisiana State University, Department of Geography & Anthropology, ATLAS lidar data, Mekong Eye, National Archives of the Netherlands, Murray-Darling Basin Authority, National Oceanic Atmospheric Administration, NASA Earth Observatory, New Orleans Historic Collection, Occidental College Special Collections, Regional Archives Dordrecht, Rijksmuseum Amsterdam, Spanish Ministry of Environment, State Library of Louisiana Historic Collection, Tennessee State Library and Archives, United Nations Food and Agriculture Organization, U.S. Department of Agriculture (NRCS), U.S. Fish and Wildlife Service, U.S. AID (Mekong ARCC Program), U.S. Geological Survey, U.S. Library of Congress, and Utrecht University Digital Historic Map Collection. An exhaustive attempt was made to properly secure rights and permissions for all figures and tables herein utilized. I'm grateful to the following individuals who kindly granted permission to use their personal photographs or figures, including Prof. S. Darby (Mekong River erosion), Prof. L. Fitcher (point bar diagram), L. Lefort (New Orleans area subsidence), N. Olsen (Bayou Goula towhead island, Mississippi River), and J. Rusky (Head of Passes, Mississippi River).

The quality and quantity of new published academic research along the themes herein examined is especially impressive and requires considerable effort to keep pace. The Mississippi and Rhine have long served as hearths of fluvial scholarship, and recent research increasingly has direct environmental, interdisciplinary, and societal relevance. An impressive flow of new large river research concerns long neglected regions, providing exceptions to the general body of knowledge of fluvial geomorphology developed in mid-latitude North America and Western Europe. This especially includes rivers in Asia and South America.

I'm keenly aware of esteemed scholars who have passed over the last decade or so, and from whom I've learned so much and whose ideas permeate this treatise, including Leal Mertes (2005), Luna Leopold (2006), Gilbert White (2006), Henk Berendsen (2007), Gordon Wolman (2010), Stan Schumm (2011), Jim Knox (2012), Jess Walker (2015), Karl Butzer (2016), Wil Graf (2019), and Ken Gregory (2020). I'm grateful to and remain in awe of their extensive contributions and dedication to river science.

I'm very appreciative of Cambridge University Press, specifically editors M. Lloyd, S. Lambert, Z. Pruce, S. Duveau, and F. Mathews Jebaraj for prompt feedback and, especially, the time and space to complete the monograph, which extended long after my relocation from Texas to the Netherlands. Critical reviews and sharp insights provided by E. M. Latrubesse, J. M. Daniels, F. T. Heitmuller, M. K. Steinberg, M. C. LaFevor, among others, and my students, who were unsuspecting critics for several years, allowed me to explore and develop a range of materials. And last – but certainly not least – this work could not have been completed without support and sacrifice from my family, who endured far too many "fragmented" weekends and "cut-off" holidays while I toiled. Thanks for your patience over all these years.