Engineering Methods for Precipitation under a Changing Climate

Edited by
J. Rolf Olsen, Ph.D.
Kelcy T. Adamec, P.E.

ASCE

Engineering Methods for Precipitation under a Changing Climate

Edited by
J. Rolf Olsen, Ph.D.
Kelcy T. Adamec, P.E.

Sponsored by
Subcommittee on Hydroclimatology and Engineering Adaptation (HYDEA) of the
Committee on Adaptation to a Changing Climate of the
American Society of Civil Engineers

Published by the American Society of Civil Engineers

Library of Congress Cataloging-in-Publication Data

Names: ASCE Workshop on Engineering Methods for Precipitation under a Changing Climate (2017 : Reston, Va.) | Olsen, J. Rolf, editor. | Adamec, Kelcy Takahashi, editor. | American Society of Civil Engineers. Hydroclimatology and Engineering Adaptation.
Title: Engineering methods for precipitation under a changing climate / edited by J. Rolf Olsen, Ph.D., Kelcy Takahashi Adamec, P.E.
Description: Reston, Virginia : American Society of Civil Engineers, [2020] | "Sponsored by Subcommittee on Hydroclimatology and Engineering Adaptation (HYDEA) of the Committee on Adaptation to a Changing Climate of the American Society of Civil Engineers"–t.p. | Includes bibliographical references and index. | Summary: "This collection contains seven peer-reviewed papers on engineering design for precipitation extremes presented at the ASCE Workshop on Engineering Methods for Precipitation under a Changing Climate, held in Reston, Virginia, May 30, 2017"– Provided by publisher.
Identifiers: LCCN 2019050944 | ISBN 9780784415528 (print) | ISBN 9780784482759 (PDF)
Subjects: LCSH: Flood control–Congresses. | Climatic changes–Congresses.
Classification: LCC TC530 .A7143 2020 | DDC 627/.4–dc23
LC record available at https://lccn.loc.gov/2019050944

Published by American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, Virginia 20191-4382
www.asce.org/bookstore | ascelibrary.org

Errata: Errata, if any, can be found at https://doi.org/10.1061/9780784415528.

ISBN 978-0-7844-1552-8 (print)
ISBN 978-0-7844-8275-9 (PDF)

Manufactured in the United States of America.

26 25 24 23 22 21 20 1 2 3 4 5

Contents

Preface

Civil engineers are responsible for the planning and design of functional, durable, and safe infrastructure. Floods and heavy precipitation events affect many types of civil engineering infrastructure. Engineering planning and design standards are based on various durations and magnitudes of these extreme precipitation events depending on the function of the infrastructure and the consequences of failure.

Engineering design has historically assumed that the past observed record of precipitation extremes and flooding will be representative of the future. This assumption is questionable under a changing climate. However, projections of future climate are also uncertain. The ensemble of all existing global climate models represents only a fraction of the full range of potential future climate, and results can vary substantially between models. It is particularly problematic to project future heavy precipitation extremes and to estimate probabilities associated with these future events.

The Subcommittee on Hydroclimatology and Engineering Adaptation (HYDEA) of ASCE's Committee on Adaptation to a Changing Climate conducted a workshop to discuss how engineers should incorporate extreme precipitation into engineering design and planning given an uncertain and changing future climate. The workshop was held at the ASCE Headquarters on May 30, 2017. Objectives were to

- Review engineering methods for designing for and managing precipitation extremes and floods throughout the life cycle of projects.
- Review approaches to uncertainty and how acceptable risk is determined.
- Communicate with climate scientists on engineering needs for climate information and receive status on climate trends, climate projections, and uncertainty.

This report is an outcome of that workshop.

This page intentionally left blank

Acknowledgments

This report is a product of the Subcommittee on Hydroclimatology and Engineering Adaptation (HYDEA) of ASCE's Committee on Adaptation to a Changing Climate. We would like to acknowledge the reviewers of the papers and the committee members who supported this effort.

Reviewers

Joshua Huang
Roger T. Kilgore
Nir Y. Krakauer
Paul M. Moody
Jayantha T. B. Obeysekera
J. Rolf Olsen

Committee on Adaptation to a Changing Climate (CACC) 2019 Executive Committee (EXCOM)

J. Rolf Olsen, *Chair*
Ana P. Barros, *Past Chair*
Constantine T. Samaras, *Vice Chair*
Miguel A. Medina, Jr., Member
Mari Rachel Tye, Member
Robert Lee Cagle, III, Committee on Technical Advancement Liaison
Jay Snyder, ASCE Staff Contact

Subcommittee on Hydroclimatology and Engineering Adaptation (HYDEA) Members

Kelcy T. Adamec
Bilal M. Ayyub
Ana Paula Barros
Lawrence Buja
Paul M. Carroll
Eun Jeong Cha
Robert E. Fields
Subhrendu Gangopadhyay
Auroop R. Ganguly
Abhishek Gaur

Joshua Huang
Shaleen Jain
Roger Trautman Kilgore
Nir Y. Krakauer
Michael A. Lacasse

CHAPTER 1

Engineering Methods for Precipitation under a Changing Climate: Practicing Engineers and the Issue of Changing Climate

Mathini Sreetharan, Ph.D., P.E.*
Jason Giovannettone, Ph.D., P.E.*

Abstract: *Climate change studies have focused on mean values of temperature and precipitation. To understand the climate future and its impact on the Nation's civil infrastructure, the qualitative terminology of "heavy," "very heavy," and "extreme" precipitation used by the climate scientist needs to be translated to the frequency rainfalls and discharges used by the civil engineer. Because of the climate change message consumed by the general public, engineers have been requested to develop 'climate resilient' designs. To accommodate climate trends into design, engineers have moved away from the comfortable zone of implementing nationally accepted design standards to developing methodologies. This paper mentions few areas where localized climate solutions are developed by engineers and provide a summary of emerging climate guidance available to the public from Federal and State Agencies. Climate stationarity is the cornerstone of all water-resources design standards. The paper concludes that two pressing needs exist: first, a national scale study to assess evidence of climate non-stationarity in rainfall stream flow records and, second, if it will impact current design standards and practices.*

Keywords: *Climate change; non-stationarity; rainfall; discharge; water-resources; design; standards*

*Dewberry