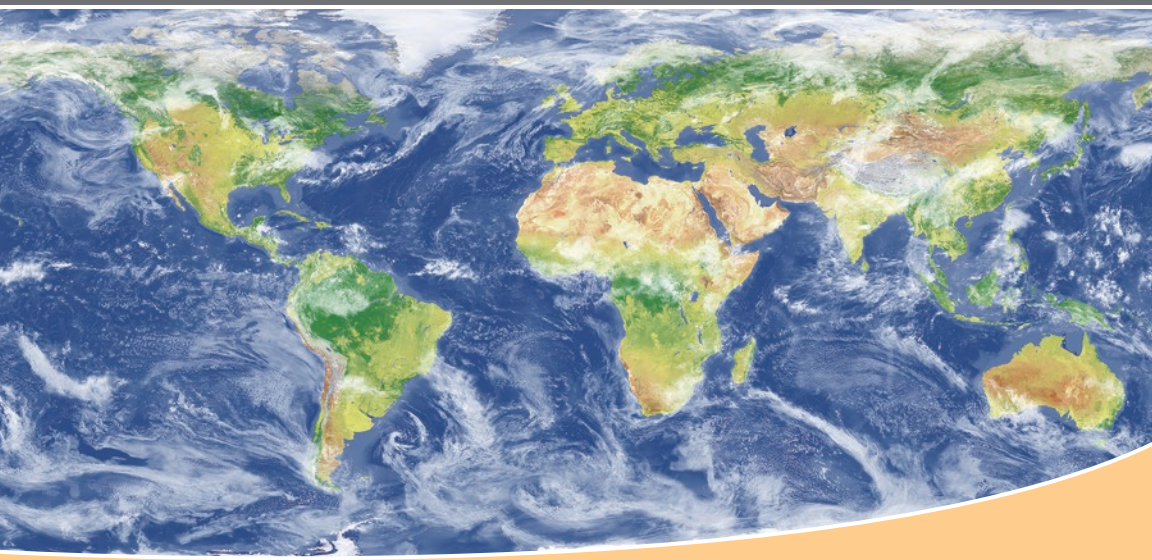
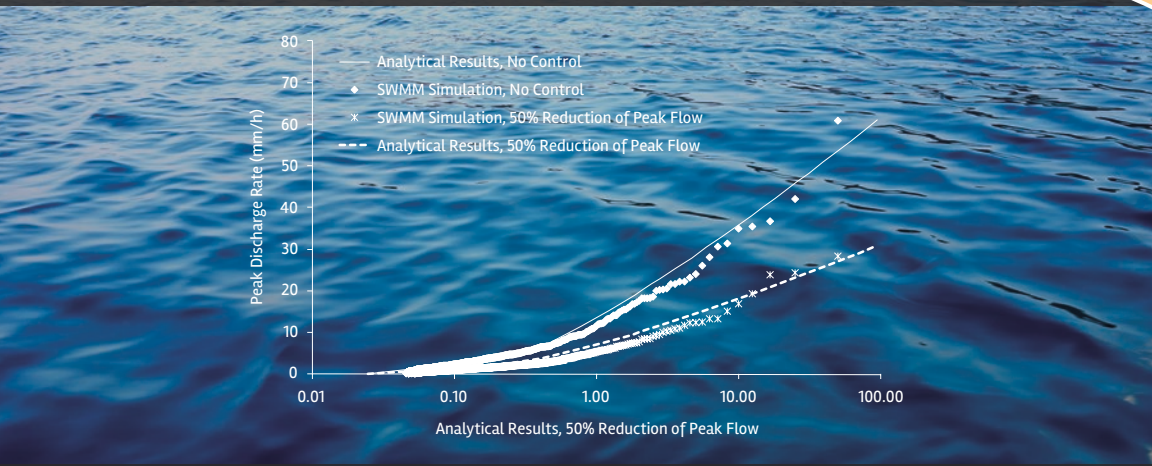


Statistical Analysis of Hydrologic Variables

Methods and Applications



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Statistical Analysis of Hydrologic Variables

Methods and Applications

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Ramesh S.V. Teegavarapu
Jose D. Salas
Jery R. Stedinger

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Preface

The Environmental and Water Resources Institute (EWRI), the American Society of Civil Engineers' (ASCE) Task Committee on "statistical distributions in hydrology," envisioned the development of a comprehensive monograph addressing uses and applications of statistical distributions in hydrology. This Task Committee was organized by the EWRI's Surface Water Hydrology Technical Committee (SWHTC) of the Watershed Council. Over several years the members of this committee struggled to determine the appropriate scope and contents of this monograph. Dr. Ahmed Nazeer led the initial vision and development of the monograph's outline and content. Subsequently, Dr. Veronica Webster, in collaboration with professors Jose D. Salas and Jery R. Stedinger, continued the effort and expanded the book's scope with the addition of selected chapters. She also supervised the writing and review of the various chapters. More recently, the SWHTC asked Dr. Ramesh Teegavarapu to take the lead in collaboration with Professors Salas and Stedinger, to re-review the chapters and complete the final steps needed for publication.

Each chapter of this book went through a peer review process by independent reviewers and the editorial team. The monograph is intended to be a standalone reference document that compiles state-of-the-art statistical methods for analyzing and describing critical variables that are part of the hydrological cycle. The monograph addresses the pressing problem of the dynamics of hydrological processes under stationary and nonstationary conditions. Developing a monograph addressing the statistical analysis of key variables in the hydrological cycle was a major undertaking, particularly as the field is evolving rapidly with a corresponding expansion of its literature. While efforts were made to be comprehensive, gaps remain to be filled. These gaps should be addressed in future hydrologic research. Nevertheless, the authors and the editors hope that this monograph, which addresses uses and applications of statistical methods, will be valuable to students, educators, researchers, and practicing hydrologists and water resource specialists. We sincerely thank the lead authors and coauthors of the chapters and the peer reviewers who have provided enormous help in the development of this monograph. We also thank EWRI for supporting the task committee's activities and helping with publication.

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CHAPTER 1

Introduction

Ramesh S.V. Teegavarapu
Jose D. Salas
Jery R. Stedinger

Characterizing and understanding the variability of hydroclimatological processes and measurements are essential for assessing the performance of water resources infrastructure and its management and for planning successful and efficient water resources projects. Spatial and temporal resolution of data are increasing with an expanding set of data sources, including remote and land-based instruments with real-time reporting. The analyzed data provide invaluable insights into the temporal and spatial dynamics of hydrological processes that represent the hydrological cycle. Historical data combined with future projections of anthropogenic and climate changes provide ample opportunities to evaluate trends and change points in the time series to develop realistic hydrologic designs and water and environmental systems management alternatives. The assessment of climate variability also relies on the evaluation of patterns and variations of historical hydroclimatological data. Hence a need exists for clear understanding and application of various data analysis methods, ranging from simple exploratory analysis to more comprehensive statistical methods.

This book aims to provide appropriate statistical methods for analyzing and modeling various parts of the hydrological cycle. Following this introductory chapter, the monograph contains 11 chapters, 2 through 12. Many chapters describe a key process in the hydrological cycle, such as precipitation, evaporation, infiltration and soil water, groundwater, and streamflow. Some chapters are devoted primarily to analyzing extreme events such as floods and low flows and droughts. Also, because watersheds and river basins often include built infrastructure and conveyances, Chapter 9 is dedicated to the hydrologic cycle that takes place in urban areas, such as precipitation and runoff, and stormwater collection and management. Most chapters emphasize the quantitative aspects of the movement of water. Chapter 10 considers the probabilistic and statistical issues related to the water quality component of the hydrologic cycle. Furthermore, because various components of the hydrologic cycle are interrelated, Chapter 11 considers the use of multivariate distributions in hydrology. Whenever possible, authors have provided examples and applications of techniques and models using real data, guidelines for data assessment, and discussion of model limitations.

Chapter 2 discusses applications of statistical methods for analysis of precipitation extremes, including a discussion about precipitation measurement and statistical estimation issues. The chapter describes probability distributions used to characterize precipitation extremes at different temporal and spatial scales and as a time series. Illustrative examples of fitting different distributions to precipitation data at different temporal scales are also presented. The chapter ends with a discussion of precipitation under a changing climate and sustainable climate change–sensitive hydrologic design that considers potential changes in the frequency of occurrences and magnitudes of precipitation extremes.