

Preface

The field of water resources engineering encompasses planning, development, and management of water resources and it covers different aspects of water engineering including municipal water supply, design of urban sewer systems to collect and treat wastewater, flood forecasting, and developing various methods to prevent water damages such as loss of property or lives, among many other disciplines. In the past few decades, many risk and uncertainty methods have been developed by water resources engineers for the purpose of finding the optimal way to design safe systems, to provide clean drinking water, and manage a range of hazards which can affect the safety of hydrosystem infrastructures. Sustainability and resiliency of hydro-infrastructure especially in densely populated urban areas, the relative importance of urban ecological environment to its residents, and the increasing economic values of water and hydrosystems to urban industrial and business establishments, requires utmost care to prevent extensive damage, and failure of hydrostructures. Hence, consideration of the probabilities of failure in the design and planning phase of these projects is a major factor in the economic analysis and life cycle cost of hydrosystem safety and operations.

Furthermore, it is necessary to train water engineering students to recognize the interconnection between topics discussed in an introductory course in stochastic and hydrologic analysis. To have a better understanding of this linkage (stochastic nature of hydrology, risk and reliability of hydrosystems design and operations), the students and practitioners in the water resources engineering field require knowledge of stochastic analysis, frequency concepts, uncertainty analysis, risk assessment/management, and the processes that predict unexpected events. To address the need of students and practitioners in this field, we have presented the basics of stochastic, risk and uncertainty analysis, and random sampling techniques in conjunction with straightforward examples which are solved step by step to guide users. In addition, we have included two other items that are different from most books on risk and uncertainty analysis. The first is applying appropriate Excel functions as an alternative method to solve the example problems, and the second is presenting two real case studies in the last chapters of book. These accessories are designed to encourage the student to understand how to use Excel

as widely used software program in the workplace today and to learn how to apply theoretical formulas, statistical relationships, and readily available tools in Excel to analyze real events.

Although existing references supply useful information relevant to the risk, reliability, and uncertainty analysis of hydrosystems, providing a practical book with focus on the applied side for undergraduate and graduate students and newcomers to this field is step forward in the training of future professionals in the water resources and actuarial fields related to flood damage insurance. In other words, what is needed is to present the basics of probability, risk, and uncertainty theories in a more simple and straight forward manner and get directly to the principal points, and apply simple examples in preparation for the use of more advanced texts. The main advantages of the current book in comparison with existing publications are:

1. Use of simple examples with step by step solution to introduce the materials in the book, and also to provide useful information to better understand the application of theoretical concepts. Hence, each chapter of this book contains a number of examples related to the basic principles of probability theories, risk, and uncertainty analyzes.
2. As Excel is one of the most widely used computer programs today, appropriate Excel functions are presented as an alternative to solve the examples. This characteristic teaches the application of Excel in risk and uncertainty analysis and makes analyzing, organizing, interpreting, and presenting results quick and easy.
3. Real case studies are valuable resources for students to apply theoretical formulas, statistical relationships, and software to analyze real events. Hence, two real world case studies based on a part of the first author's doctoral dissertation research are presented in [Chaps. 5](#) and [6](#) and the process of evaluating overtopping risk of an embankment dam under various risk scenarios are explained. Regarding these examples, students are trained to apply theoretical formulas, statistical relationships, and computer programs to analyze real events.
4. Finally, most risk and uncertainty studies on hydrosystem engineering (1967–2012) are presented in the book's Appendix in table format which includes researcher(s) names, dates of study, and brief description of their work. With the help of these tables, readers can easily find all previous studies related to hydrosystem risk and uncertainty analysis.

To sum up, the main purpose of this book is to serve as guide for conducting and incorporating risk and uncertainty analyses in water resource planning processes. This book's main theme is to improve understanding of the quantity and quality of information we have, and the importance of information we do not have, for the purpose of improving decision making. The principal audiences of this book are undergraduate and graduate students of water engineering and all new researchers who are interested in academic research associate with risk and uncertainty analysis as well as practitioners in the field of risk management. Furthermore, this book can be used as reference for teaching in various fields of

water engineering including: hydrology, hydraulic, water resources analysis, water quality analysis, etc. This book is also a useful reference for practicing engineers/professionals as well as students and individual researchers. They can apply risk analysis as a useful tool to make best decisions when designing for unaccounted loads. In addition, risk based analysis can provide a means for practicing engineers to determine the probability of success or failure of the project not only from a technical point of view, but also from financial point of view.

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