

Preface

Decision making is an essential part of our private and professional life. The consequences of our decisions are sometimes very simple, but very often our decisions affect our life and future significantly. For example, selecting a dessert after a dinner is a simple decision, however applying for a new job or choosing a retirement plan could have significant effect on our life.

Every decision making problem has three major components: the decision makers, the decision alternatives, and the consequences of our decisions. The decision maker can be a single person or a group of people, who are sometimes called the stakeholders. The decision alternatives are the options from which we can choose from. In selecting the feasible alternative set we have to take into account all of the technical, economic, environmental, regulatory, etc., constraints. If the consequences of a decision making problem can be characterized by a single criterion (such as profit), then the problem can be modeled as a single-objective optimization problem. Depending on the types of the objective function and the feasible set of alternatives the mathematical model can be linear programming, or a nonlinear, discrete, mixed programming problem or even dynamic or stochastic optimization to mention only the most frequently used model variants. There are many textbooks discussing these model types and the most important solution methodology. Most of the practical decision making problems cannot be described by a single criterion. Water resources and environmental management problems always have to consider several criteria simultaneously,

social and other economic factors have to be considered among others. Multi Criteria Decision Analysis (MCDA) is the usual methodology to model and solve such problems. This book attempts to introduce the modeling and solving of MCDA problems with illustrative case studies in water resources and environmental management. Chapter 1 presents the major components and modeling of MCDA problems. The hierarchy of the criteria is the subject of Chapter 2. The most important methods for solving discrete problems are introduced in Chapter 3, and their counterparts for solving continuous problems are discussed in Chapter 4. Social choice methodology is often used if there are several stakeholders with conflicting priorities in the decision making process when some of the criteria are hard to or cannot be quantified. Chapter 5 is devoted to this subject. Conflict resolution concepts and procedures are introduced in Chapter 6 including symmetric and non-symmetric bargaining. All models and methods discussed in the first six chapters assume complete and perfect knowledge of all criteria and constraints. However, in reality most decision making problems are faced with uncertain environmental and economical conditions. Chapter 7 introduces the main concepts of modeling uncertainty and the corresponding solution methodology. In addition to introducing and discussing modeling concepts and mathematical methodology with simple classroom-size numerical examples, several case studies are selected to illustrate how they work in reality. These case studies include project selection, inter-basin water transfer, urban water management, water allocation, groundwater quality as environmental health risk, forestry treatment selection, multi-reservoir irrigation planning, water distribution network design, and long-term watershed management. These studies are chosen from different regions and countries including Hungary, India, Iran, Mexico, USA and Vietnam.

This book is a result of the 4-year long cooperation of the authors which started with a 1-year scholarship of the first author at the University of Arizona, Tucson. This visit was followed by several meetings, conferences and short courses, when the authors could exchange ideas and earlier drafts of different parts of the manuscript of this book.

We hope that the material of this book will be helpful for graduate students in mathematics, engineering and economics in their studies in decision making. We also hope that engineers, managers and all others facing with practical decision making problems will find the material of this book useful in their work. The methodology and the concrete application studies might suggest new ideas, interesting and important research topics for students and scientists.

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