

Preface

Modeling is a simplification, an abstraction of reality. It is an analytical tool that we all willingly or unwillingly employ in our everyday life when we build mental, graphical, textual, or other models of reality. With the advent of computers, we learned to use them to further our ability to model the world around us, and the more sophisticated and powerful the computers become and the more elaborate the software we develop, the more complexity we can afford in our models.

It is only during the last decade that spatial dynamic modeling became possible for analysis of large-scale real-life ecosystems. The need to model ecosystem dynamics spatially is becoming even more obvious with the widespread use of spatial databases, called Geographic Information Systems. Many, if not most, management decisions concerning the environment affect and are affected by the landscape and by how it evolves in space and in time. This book puts you at the cutting edge of the science of spatial dynamic simulation modeling. The Spatial Modeling Environment (SME) is an open-source software package that we use in conjunction with other software to create, run, analyze, and present spatial models of ecosystems, watersheds, populations, and landscapes. We will walk you through the whole process of spatial modeling, starting with the conceptual design, then the formal implementation and analysis, and, finally, interpretation and presentation of the results. Numerous applications and case studies will help identify the possible ambiguities and problems that a modeler should be aware of and try to avoid.

The book will be useful for students and researchers interested in modeling, especially in spatial modeling; it will provide ideas and software tools to translate their local understanding of systems dynamics over space. It will be useful for managers and decision makers who want to know what is possible and what is not possible today in spatial modeling and how to treat the uncertainties and insufficiencies in our predictions of spatial dynamics.

Part I describes the theory and methods of spatially explicit modeling. We introduce the Spatial Modeling Environment and demonstrate how it can be used to build simple models. We also offer a collection of some basic modules that can be

used off the shelf to build some models of landscapes. We then explore the issues of model calibration and analysis.

Part II is about real applications of the modeling framework that answer some pressing environmental and socio-economic problems. What are the impacts of diverse climates and management plans for Barataria and Terrebonne basins in the Mississippi Delta? What can be the effects of sea-level rise? What are the patterns of the dynamic spread of fox rabies across the state of Illinois and what can be the possible disease control strategies? How do growing nutrient loading and land use change affect the water quality in the Patuxent River and the Chesapeake Bay? What can be the best restoration and mitigation practices? What are the probabilities of extinction of the vireo and warbler populations, two endangered passerines at Fort Hood, an Army training installation in central Texas? How do we allocate crops on a watershed to maximize the agricultural profits, yet minimize the damage to the water quality in the receiving waterways? To what extent has the combination of altered hydrology and water quality degraded the vegetative habitats and other ecological characteristics of the Everglades? What needs to be done to “restore” the Everglades? What is the future of the once abundant eelgrass meadows in the Great Bay Estuary in New Hampshire? What are the impacts of military training across time and space in the Mojave Desert on a federally threatened population of the desert tortoise (*Gopherus agassizii*) and its habitat?

These issues reveal the scope of problems and geographic areas that we cover in these chapters. A CD-ROM is provided with the book. Here, we offer all of the software that is required to install the SME on your computer (SME currently runs under UNIX, Linux, and Windows; it can be installed under Darwin in Mac OS-X). The Java-based interface is platform independent. In addition, we have assembled the Web pages for most of the chapters that give a detailed description of the corresponding projects and offer all of the color graphics, animations, and data to explore and better visualize the possible applications of models for decision-making and management.

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A Spatially Explicit, Dynamic Approach

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