

# **Mathematical Modelling of Environmental and Ecological Systems**

Edited by

**J.B. Shukla**

**T.G. Hallam**

and

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# Mathematical Modelling Of Environmental And Ecological Systems

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## **Mathematical Modelling Of Environmental And Ecological Systems:**

**Mathematical Modelling of Environmental and Ecological Systems** J.B. Shukla,T.G. Hallam,V. Capasso,2012-12-02

This volume contains a cross section of the papers presented at the International Symposium on Mathematical Modelling of Ecological Environmental and Biological Systems held in Kanpur India in August 1985 The choice of topics emphasizes many aspects of ecological and environmental matters including air and water pollution ecotoxicology resource management epidemiology and population and community ecology It is intended that this volume will focus international attention upon some problems in the ecological and environmental sciences that can be impacted by mathematical modelling and analysis

*Mathematical Modelling of Environmental and Ecological Systems* ENVIRONMENTAL AND BIOLOGICAL SYSTEMS INTERNATIONAL SIMPOSIUM ON MATHEMATICAL MODELLING OF ECOLOGICAL,1987 Air pollution Some aspects of mathematical modelling of atmospheric transport and chemistry Attenuation of air pollution by green belt Dispersion of a reactive air pollutant in a two layered environment Dispersion from a time dependent point source Application to methyl isocyanate leakage in Bhopal India Water pollution Taking advantage of topography in siting of discharges in rivers Analytical solution of 3 D unsteady state diffusion equation for a pollutant from a point source discharge in offshore region Population ecology Modelling survival in chemically stressed populations On the general structure of epidemic models Equilibria and oscillations in age structure population growth models Community ecology Young predation and time delays Uniform persistence and global stability in models involving mutualism I predator prey mutualistic systems Resource management Dynamic interactions between economic ecological and demographic variables Economic growth models Effects of logistic population and technology A dynamic predator prey model for the utilization of fishery resources a case of trawling in lake Kasumigaura Mathematical Modelling of Environmental and Ecological Systems J. B. Shukla,Thomas G. Hallam,Vincenzo Capasso,1987 This volume contains a cross section of the papers presented at the International Symposium on Mathematical Modelling of Ecological Environmental and Biological Systems held in Kanpur India in August 1985 The choice of topics emphasizes many aspects of ecological and environmental matters including air and water pollution ecotoxicology resource management epidemiology and population and community ecology It is intended that this volume will focus international attention upon some problems in the ecological and environmental sciences that can be impacted by mathematical modelling and analysis **Mathematical Modeling in Economics, Ecology and the Environment** N.V. Hritonenko,Yuri P.

Yatsenko,2013-04-17 The problems of interrelation between human economics and natural environment include scientific technical economic demographic social political and other aspects that are studied by scientists of many specialities One of the important aspects in scientific study of environmental and ecological problems is the development of mathematical and computer tools for rational management of economics and environment This book introduces a wide range of mathematical models in economics ecology and environmental sciences to a general mathematical audience with no in depth experience in

this specific area Areas covered are controlled economic growth and technological development world dynamics environmental impact resource extraction air and water pollution propagation ecological population dynamics and exploitation A variety of known models are considered from classical ones Cobb Douglass production function Leontief input output analysis Solow models of economic dynamics Verhulst Pearl and Lotka Volterra models of population dynamics and others to the models of world dynamics and the models of water contamination propagation used after Chernobyl nuclear catastrophe Special attention is given to modelling of hierarchical regional economic ecological interaction and technological change in the context of environmental impact

XIII XIV Construction of Mathematical Models     Mathematical Modeling in Economics, Ecology and the Environment Natali Hritonenko, Yuri Yatsenko, 2014-01-08 Updated to textbook form by popular demand this second edition discusses diverse mathematical models used in economics ecology and the environmental sciences with emphasis on control and optimization It is intended for graduate and upper undergraduate course use however applied mathematicians industry practitioners and a vast number of interdisciplinary academics will find the presentation highly useful Core topics of this text are Economic growth and technological development Population dynamics and human impact on the environment Resource extraction and scarcity Air and water contamination Rational management of the economy and environment Climate change and global dynamics The step by step approach taken is problem based and easy to follow The authors aptly demonstrate that the same models may be used to describe different economic and environmental processes and that similar investigation techniques are applicable to analyze various models Instructors will appreciate the substantial flexibility that this text allows while designing their own syllabus Chapters are essentially self contained and may be covered in full in part and in any order Appropriate one and two semester courses include but are not limited to Applied Mathematical Modeling Mathematical Methods in Economics and Environment Models of Biological Systems Applied Optimization Models and Environmental Models Prerequisites for the courses are Calculus and preferably Differential Equations

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details of the underlying mathematics and that encourages learning through hands on experimentation He provides a set of software tools and data sets that you can use to work through the various examples and exercises presented in each chapter as well as presentational material and handouts for course tutors Comprehensive and up to date the book discusses how computational models can be used to represent environmental systems and illustrates how such models improve understanding of the ways in which environmental systems function      **Environmental Modeling** Mike J.

Barnsley,2007-02-13 Increasingly used to represent climatic biogeochemical and ecological systems computer modeling has become an important tool that should be in every environmental professional s toolbox Environmental Modeling A Practical Introduction is just what it purports to be a practical introduction to the various methods techniques and skills required for computerized environmental modeling Exploring the broad arena of environmental modeling the book demonstrates how to represent an environmental problem in conceptual terms formalize the conceptual model using mathematical expressions convert the mathematical model into a program that can be run on a desktop or laptop computer and examine the results produced by the computational model Equally important the book imparts skills that allow you to develop implement and experiment with a range of computerized environmental models The emphasis is on active engagement in the modeling process rather than on passive learning about a suite of well established models The author takes a practical approach throughout one that does not get bogged down in the details of the underlying mathematics and that encourages learning through hands on experimentation He provides a set of software tools and data sets that you can use to work through the various examples and exercises presented in each chapter as well as presentational material and handouts for course tutors Comprehensive and up to date the book discusses how computational models can be used to represent environmental systems and illustrates how such models improve understanding of the ways in which environmental systems function

**Models of the Ecological Hierarchy** ,2012-12-31 In the application of statistics to ecological inference problems hierarchical models combine explicit models of ecological system structure or dynamics with models of how ecological systems are observed The principles of hierarchical modeling are applied in this book to a wide range of problems ranging from the molecular level through populations ecosystems landscapes networks through to the global ecosphere Provides an excellent introduction to modelling Collects together in one source a wide range of modelling techniques Covers a wide range of topics from the molecular level to the global ecosphere      **Ecological Modeling** Hsiao-Hsuan Wang,William E. Grant,2019-08-14 Ecological Modeling An Introduction to the Art and Science of Modeling Ecological Systems Volume 31 presents the skills needed to appropriately evaluate and use ecological models Illustrated throughout with practical examples the book discusses ecological modeling as both an art and a science balancing the qualitative artistic side with its foundations in common sense and modeling practice against the quantitative scientific aspects of the modeling process This book draws on the authors extensive experience in both teaching and using these techniques to provide readers with a

practical user friendly guide that supports and encourages the appropriate effective use of these tools Provides readers with a commonsense understanding of the systems perspective and its foundations in general system theory Highlights the importance of a solid understanding of the qualitative aspects of the modeling process Facilitates the ability to appropriately evaluate and use ecological models Supports learning with a variety of simple examples to instill the desire and confidence to embark upon the modeling experience

*Modelling in Ecotoxicology* S.E. Jorgensen,2013-10-22 Ecotoxicology is the science of toxic substances in the environment and their impact on living organisms Today we use many more chemicals in everyday life than we did 30 40 years ago Our knowledge of the fate and effect of such chemicals in the environment has not yet followed the rate of chemical innovation in spite of our expanding knowledge of ecotoxicology About 50 000 different chemicals are produced on an industrial scale but we have only sufficient data to evaluate the environmental consequences of a few per cent of these The need for ecotoxicological knowledge has never been more pronounced than it is today Even more resources must be allocated in this field in the near future if we are to be able to cope with the threat of more toxic chemical compounds in our environment This book outlines the state of the art of modelling the fate and effects of toxic substances in the environment Modelling in ecotoxicology differs from modelling in other fields by the great lack of data The quality of the models is very dependent on the parameters used and as we do not have a wide knowledge of parameters in ecotoxicological processes good parameter estimation methods are crucial for ecotoxicological models A comprehensive review of available parameter estimation methods is therefore included in this volume Model examples and case studies have also been included to illustrate the difficulties and short comings in practical modelling

**Ecological Modelling and Engineering of Lakes and Wetlands** ,2014-04-04 Ecological modelling has developed rapidly in recent decades with the focus primarily on the restoration of lakes and wetlands Ecological Modelling and Engineering in Lakes and Wetlands presents the progress being made in modelling for a wealth of applications It covers the older biogeochemical models still in use today structurally dynamic models 3D models biophysical models entire watershed models and ecotoxicological models as well as the expansion of modeling to the Arctic and Antarctic climate zones The book also addresses modelling the effect of climate change including the development of ecological models for addressing storm water pond issues which are increasingly important in urban regions where more concentrated rainfalls are a consequence of climate change The ecological engineering topics covered in the book also emphasize the advancements being made in applying ecological engineering regimes for better environmental management of lakes and wetlands Examines recent progress towards a better understanding of these two important ecosystems Presents new results and approaches that can be used to develop better models Discusses how to increase the synergistic effect between ecosystems engineering and modelling

Mathematics for Ecology and Environmental Sciences Yasuhiro Takeuchi,Yoh Iwasa,Kazunori Sato,2007-01-19 Dynamical systems theory in mathematical biology has attracted much attention from many scientific directions The purpose of this volume is to discuss

the many rich and interesting properties of dynamical systems that appear in ecology and environmental sciences The main topics include population dynamics with dispersal nonlinear discrete population dynamics structured population models mathematical models in evolutionary ecology stochastic spatial models in ecology game dynamics and the chemostat model Each chapter will serve to introduce students and scholars to the state of the art in an exciting area to present important new results and to inspire future contributions to mathematical modeling in ecology and environmental sciences

Time and Methods in Environmental Interfaces Modelling Dragutin T Mihailovic,Igor Balaž,Darko Kapor,2016-10-31 Time and Methods in Environmental Interfaces Modelling Personal Insights considers the use of time in environmental interfaces modeling and introduce new methods from the global scale e g climate modeling to the micro scale e g cell and nanotubes modeling which primarily arise from the personal research insights of the authors As the field of environmental science requires the application of new fundamental approaches that can lead to a better understanding of environmental phenomena this book helps necessitate new approaches in modeling including category theory that follow new achievements in physics mathematics biology and chemistry Includes the use of new mathematical tools such as category theory mathematical theory of general systems and formal concept analysis matrix theory tools stability analysis and pseudospectra Presents new content related to time in relation to physics and biology Combines the word of an experienced author team with over 35 papers of collective experience

Fundamentals of Ecological Modelling S.E. Jorgensen,2001-08-14 This is a thoroughly revised and updated edition of an authoritative introduction to ecological modelling Sven Erik J rgensen Editor in Chief of the journal Ecological Modelling and Giuseppe Bendoricchio Professor of Environmental Modelling at the University of Padova Italy offer compelling insights into the subject This volume explains the concepts and processes involved in ecological modelling presents the latest developments in the field and provides readers with the tools to construct their own models The Third Edition features A detailed discussion and step by step outline of the modelling procedure An account of different model types including overview tables examples and illustrations A comprehensive presentation of the submodels and unit processes used in modelling In depth descriptions of the latest modelling techniques Structured exercises at the end of each chapter Three mathematical appendices and a subject index This practical and proven book very effectively combines the theory methodology and applications of ecological modelling The new edition is an essential up to date guide to a rapidly growing field

**Advanced Modelling Techniques Studying Global Changes in Environmental Sciences** ,2015-10-08 Advanced Modelling Techniques Studying Global Changes in Environmental Sciences discusses the need for immediate and effective action guided by a scientific understanding of ecosystem function to alleviate current pressures on the environment Research especially in Ecological Modeling is crucial to support the sustainable development paradigm in which the economy society and the environment are integrated and positively reinforce each other Content from this book is drawn from the 2013 conference of the International Society for Ecological Modeling ISEM an important and active research community

contributing to this arena Some progress towards gaining a better understanding of the processes of global change has been achieved but much more is needed This conference provides a forum to present current research using models to investigate actions towards mitigating and adapting to change Presents state of the art modeling techniques Drawn from the 2013 conference of the International Society for Ecological Modeling ISEM an important and active research community contributing to this arena Integrates knowledge of advanced modeling techniques in ecological and environmental sciences Describes new applications for sustainability

**The Water-Energy-Food Nexus** Brenda Cansino-Loeza, José Maria Ponce-Ortega, 2023-11-03 The Water Energy Food Nexus Optimization Models for Decision Making covers the discussion about water energy and food as a crucial resource for human well being and for sustainable development These resources are inextricable interrelated therefore to cover water energy and food demands in different sectors and at different scales it must be considered several sources to produce resources even conventional or unconventional and there must be considered the interlinkages of resources for a proper integration This book will emphasize several issues that must be considered in the design of water energy food nexus systems such as the selection of technologies to produce water or energy size of technologies and food required to cover nutritional demands Therefore in The Water Energy Food Nexus Optimization Models for Decision Making mathematical models are presented for the design of water energy food nexus systems involving several strategies to account for issues like sustainable development security of resources interest in conflicts from stakeholders and efficient allocation of resources Includes different optimization models for the integration of water energy food nexus Considers sustainability criteria in the presented models Helps readers understand different approaches for trade off solutions Presents general software that can be used in solving different problems

Numerical Ecology P. Legendre, Louis Legendre, 2012-07-21 The book describes and discusses the numerical methods which are successfully being used for analysing ecological data using a clear and comprehensive approach These methods are derived from the fields of mathematical physics parametric and nonparametric statistics information theory numerical taxonomy archaeology psychometry sociometry econometry and others An updated 3rd English edition of the most widely cited book on quantitative analysis of multivariate ecological data Relates ecological questions to methods of statistical analysis with a clear description of complex numerical methods All methods are illustrated by examples from the ecological literature so that ecologists clearly see how to use the methods and approaches in their own research All calculations are available in R language functions

**Analysis of Ecological Systems: State-of-the-Art in Ecological Modelling** W.K. Lauenroth, G.V. Skogerboe, M. Flug, 2013-10-22 The International Society for Ecological Modelling ISEM sponsors conferences workshops and training courses with the aim of advancing the development of ecological and environmental modelling The 3rd International Conference on the state of the art in ecological modelling was sponsored by the ISEM in cooperation with the National Park Service Water Resources Laboratory and hosted by the Natural Resource Ecology Laboratory at Colorado



State University Its theme was the application of ecological modelling to environmental management and this book contains the full texts of the three invited papers presented in the five general sessions plus the final summaries and syntheses of the topics covered during those sessions Dimensions of Environmental and Ecological Economics Nirmal Chandra

Sahu, Amita Kumari Choudhury, 2005 Besides Covering The Paradigmatic Bases Of Environmental Ecological And Natural Resource Economics This Book Discusses The Economic Dimensions Of And Approaches To Pollution Environmental And Ecosystem Management Biodiversity Global Warming Energy And Resource Use And Sustainable Development

**Population Parameters** Hamish McCallum, 2008-04-15 Ecologists and environmental managers rely on mathematical models both to understand ecological systems and to predict future system behavior In turn models rely on appropriate estimates of their parameters This book brings together a diverse and scattered literature to provide clear guidance on how to estimate parameters for models of animal populations It is not a recipe book of statistical procedures Instead it concentrates on how to select the best approach to parameter estimation for a particular problem and how to ensure that the quality estimated is the appropriate one for the specific purpose of the modelling exercise Commencing with a toolbox of useful generic approaches to parameter estimation the book deals with methods for estimating parameters for single populations These parameters include population size birth and death rates and the population growth rate For such parameters rigorous statistical theory has been developed and software is readily available The problem is to select the optimal sampling design and method of analysis The second part of the book deals with parameters that describe spatial dynamics and ecological interactions such as competition predation and parasitism Here the principle problems are designing appropriate experiments and ensuring that the quantities measured by the experiments are relevant to the ecological models in which they will be used This book will be essential reading for ecological researchers postgraduate students and environmental managers who need to address an ecological problem through a population model It is accessible to anyone with an understanding of basic statistical methods and population ecology Unique in concentrating on parameter estimation within modelling Fills a glaring gap in the literature Not too technical so suitable for the statistically inept Methods explained in algebra but also in worked examples using commonly available computer packages SAS GLIM and some more specialised packages where relevant Some spreadsheet based examples also included

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