

# Resilience and the Behavior of Large-Scale Systems



*Edited by*

Lance H. Gunderson

Lowell Pritchard Jr.

# Resilience And The Behavior Of Largescale Systems

**J. Barkley Rosser**



## **Resilience And The Behavior Of Largescale Systems:**

Resilience and the Behavior of Large-Scale Systems Lance H. Gunderson, Lowell Pritchard, 2002-10 Scientists and researchers concerned with the behavior of large ecosystems have focused in recent years on the concept of resilience. Traditional perspectives held that ecological systems exist close to a steady state and resilience is the ability of the system to return rapidly to that state following perturbation. However, beginning with the work of C. S. Holling in the early 1970s, researchers began to look at conditions far from the steady state where instabilities can cause a system to shift into an entirely different regime of behavior and where resilience is measured by the magnitude of disturbance that can be absorbed before the system is restructured. *Resilience and the Behavior of Large Scale Systems* examines theories of resilience and change, offering readers a thorough understanding of how the properties of ecological resilience and human adaptability interact in complex regional scale systems. The book addresses the theoretical concepts of resilience and stability in large scale ecosystems as well as the empirical application of those concepts in a diverse set of cases. In addition, it discusses the practical implications of the new theoretical approaches and their role in the sustainability of human modified ecosystems. The book begins with a review of key properties of complex adaptive systems that contribute to overall resilience, including multiple equilibria, complexity, self-organization at multiple scales, and order. It also presents a set of mathematical metaphors to describe and deepen the reader's understanding of the ideas being discussed. Following the introduction are case studies that explore the biophysical dimensions of resilience in both terrestrial and aquatic systems and evaluate the propositions presented in the introductory chapters. The book concludes with a synthesis section that revisits propositions in light of the case studies, while an appendix presents a detailed account of the relationship between return times for a disturbed system and its resilience. In addition to the editors, contributors include Stephen R. Carpenter, Carl Folke, C. S. Holling, Bengt Owe Jansson, Donald Ludwig, Ariel Lugo, Tim R. McClanahan, Garry D. Peterson, and Brian H. Walker. **Sustainable and Resilient**

**Critical Infrastructure Systems** Kasthurirangan Gopalakrishnan, Srinivas Peeta, 2010-04-13 Sustainable and resilient critical infrastructure systems is an emerging paradigm in an evolving era of depleting assets in the midst of natural and man-made threats to provide a sustainable and high quality of life with optimized resources from social, economic, societal, and environmental considerations. The increasing complexity and interconnectedness of civil and other interdependent infrastructure systems, electric power, energy, cyber infrastructures, etc., require inter- and multidisciplinary expertise required to engineer, monitor, and sustain these distributed large scale complex adaptive infrastructure systems. This edited book is motivated by recent advances in simulation, modeling, sensing, communications, information, and intelligent and sustainable technologies that have resulted in the development of sophisticated methodologies and instruments to design, characterize, optimize, and evaluate critical infrastructure systems, their resilience, and their condition, and the factors that cause their deterioration. Specific topics discussed in this book include, but are not limited to, optimal infrastructure investment allocation.

for sustainability framework for manifestation of tacit critical infrastructure knowledge interdependencies between energy and transportation systems for national long term planning intelligent transportation infrastructure technologies emergent research issues in infrastructure interdependence research framework for assessing the resilience of infrastructure and economic systems maintenance optimization for heterogeneous infrastructure systems optimal emergency infrastructure inspection scheduling and sustainable rehabilitation of deteriorated transportation infrastructure systems

*Resilience and the Behavior of Large-Scale Systems* Lance H. Gunderson, Lowell Pritchard, 2012-06-22 Scientists and researchers concerned with the behavior of large ecosystems have focused in recent years on the concept of resilience Traditional perspectives held that ecological systems exist close to a steady state and resilience is the ability of the system to return rapidly to that state following perturbation However beginning with the work of C S Holling in the early 1970s researchers began to look at conditions far from the steady state where instabilities can cause a system to shift into an entirely different regime of behavior and where resilience is measured by the magnitude of disturbance that can be absorbed before the system is restructured *Resilience and the Behavior of Large Scale Systems* examines theories of resilience and change offering readers a thorough understanding of how the properties of ecological resilience and human adaptability interact in complex regional scale systems The book addresses the theoretical concepts of resilience and stability in large scale ecosystems as well as the empirical application of those concepts in a diverse set of cases In addition it discusses the practical implications of the new theoretical approaches and their role in the sustainability of human modified ecosystems The book begins with a review of key properties of complex adaptive systems that contribute to overall resilience including multiple equilibria complexity self organization at multiple scales and order it also presents a set of mathematical metaphors to describe and deepen the reader s understanding of the ideas being discussed Following the introduction are case studies that explore the biophysical dimensions of resilience in both terrestrial and aquatic systems and evaluate the propositions presented in the introductory chapters The book concludes with a synthesis section that revisits propositions in light of the case studies while an appendix presents a detailed account of the relationship between return times for a disturbed system and its resilienc In addition to the editors contributors include Stephen R Carpenter Carl Folke C S Holling Bengt Owe Jansson Donald Ludwig Ariel Lugo Tim R McClanahan Garry D Peterson and Brian H Walker

Critical Infrastructure System Security and Resiliency Betty Biringer, Eric Vugrin, Drake Warren, 2013-04-12 Security protections for critical infrastructure nodes are intended to minimize the risks resulting from an initiating event whether it is an intentional malevolent act or a natural hazard With an emphasis on protecting an infrastructure s ability to perform its mission or function *Critical Infrastructure System Security and Resiliency* presents a practical methodology for developing an effective protection system that can either prevent undesired events or mitigate the consequences of such events Developed at Sandia National Labs the authors analytical approach and methodology enables decision makers and security experts to perform and utilize risk assessments in a manner that extends

beyond the theoretical to practical application These protocols leverage expertise in modeling dependencies optimizing system resiliency for effective physical protection system design and consequence mitigation The book begins by focusing on the design of protection strategies to enhance the robustness of the infrastructure components The authors present risk assessment tools and necessary metrics to offer guidance to decision makers in applying sometimes limited resources to reduce risk and ensure operational resiliency Our critical infrastructure is vast and made up of many component parts In many cases it may not be practical or affordable to secure every infrastructure node For years experts as a part of the risk assessment process have tried to better identify and distinguish higher from lower risks through risk segmentation In the second section of the book the authors present examples to distinguish between high and low risks and corresponding protection measures In some cases protection measures do not prevent undesired events from occurring In others protection of all infrastructure components is not feasible As such this section describes how to evaluate and design resilience in these unique scenarios to manage costs while most effectively ensuring infrastructure system protection With insight from the authors decades of experience this book provides a high level practical analytical framework that public and private sector owners and operators of critical infrastructure can use to better understand and evaluate infrastructure security strategies and policies Strengthening the entire homeland security enterprise the book presents a significant contribution to the science of critical infrastructure protection and resilience

*Rangeland Systems* David D. Briske, 2017-04-12 This book is open access under a CC BY NC 2.5 license This book provides an unprecedented synthesis of the current status of scientific and management knowledge regarding global rangelands and the major challenges that confront them It has been organized around three major themes The first summarizes the conceptual advances that have occurred in the rangeland profession The second addresses the implications of these conceptual advances to management and policy The third assesses several major challenges confronting global rangelands in the 21st century This book will compliment applied range management textbooks by describing the conceptual foundation on which the rangeland profession is based It has been written to be accessible to a broad audience including ecosystem managers educators students and policy makers The content is founded on the collective experience knowledge and commitment of 80 authors who have worked in rangelands throughout the world Their collective contributions indicate that a more comprehensive framework is necessary to address the complex challenges confronting global rangelands Rangelands represent adaptive social ecological systems in which societal values organizations and capacities are of equal importance to and interact with those of ecological processes A more comprehensive framework for rangeland systems may enable management agencies and educational research and policy making organizations to more effectively assess complex problems and develop appropriate solutions

**Sustainability Science: Field Methods and Exercises** Miguel Esteban, Tomohiro Akiyama, Chiahshin Chen, Izumi Ikeda, Takashi Mino, 2016-07-29 This book builds up on the experience and lessons learnt by academics at the Graduate Program in Sustainability Science Global Leadership

Initiative GPSS GLI at the University of Tokyo A number of scholars in the new field of sustainability science describe how field methods and exercises are carried out in this discipline together with the theoretical basis for such exercises Case studies of various countries around the world where these exercises are carried out are showcased emphasizing the various socio economic considerations and problems facing humanity and possible ways forward to build more sustainable and resilient societies The final objective is to enrich the field of sustainability science by describing the novel aspects used in the field exercises carried out by practitioners of this cross disciplinary field **Stress and Poverty** Michael

Breitenbach, Elisabeth Kapferer, Clemens Sedmak, 2021-07-22 The word stress is everywhere and highly overused Everyone is stressed it seems all the time Looking into the meaning of stress in the natural science and the humanities this book explores cellular stress as cause of and in correlation with what humans experience as stress When do we psychologically feel stress and when do we show physiological evidence of stress in our brain Stress is a deviation from what feels normal and healthy It can be created by social or economic factors and become chronic which has substantial impacts on the individual and society as a whole Focusing on poverty as one chronic inducer of stress this book explores how the lack of pressure free time the hardships and unpredictability of everyday life and a general lack of protection lead to destructive toxic stress This pressure affects cognitive and social functioning brain development during childhood and may also result in premature aging How can the sciences inform our understanding of and our response to stress What can be done about toxic stress both on a personal level and in terms of structures and policies The book is written for anyone interested in stress its causes and consequences and its relationship to poverty **The Law and Ecology of Pesticides and Pest Management** Mary Jane

Angelo, 2016-03-03 Although concerns over the ecological impacts of pesticides gave rise to the environmental movement of the late 1960s and 1970s since that time pesticide use and its effects have been largely ignored by the law and by legal scholars This book addresses this omission by providing a unique and serious treatment of the significance of pesticide issues in environmental law and takes an ecological perspective on the legal issues Dealing with a wide range of questions relating to pests and pesticides the book focuses primarily on agricultural pesticide use as the largest contaminator in the US It also examines the legacy of past pesticide use and analyzes how recent developments in ecological science can inform the law and increase our understanding of ecology Interdisciplinary in its approach the book will be of interest to academics lawyers scientists and environmental and agricultural professionals **Beyond Reductionism** Katharine Farrell, Tommaso

Luzzati, Sybille van den Hove, 2013-05-07 This is a book about the work of scientists in the era of the Anthropocene where human beings appear to have become a driving force in the evolution of the planet It is a diverse collection of empirical methodological and theoretical chapters concerned with the practice of interdisciplinary social ecological systems research The aim of the contributors is to give the reader an appreciation for the range and complexity of the challenges faced by researchers research institutions and wider communities trying to make sense of the causes and consequences of the this

new era of global environmental change The tragedy of the Anthropocene of the large scale anthropogenic habitat destruction and planet wide impacts of anthropogenic climate change is not that science has failed humanity but rather that it has served humanity all too well making possible in just a few hundred years volumes and scales of human activity far exceeding anything ever seen before Coming to terms with that success was the aim of the 1969 Alpbach Symposium from which this book draws its name where contributors including Friedrich Hayek and Ludwig von Bertalanffy asked themselves what theory practices and standards are required to move beyond reductionism Like those from 1969 the answers presented in this collection are hugely diverse ranging from PhD students concerned with research methods and institutional obstacles to mid career scholars presenting their innovative beyond reductionism research methods to emeritus professors looking back over what has been achieved in the past 30 years and suggesting where things might go from here All the contributors begin from the premise that the challenges of the Anthropocene can only be successfully met if interdisciplinary research effectively brings together social and natural sciences the humanities stakeholders and decision makers They conclude in unison that both the institutional and the methodological foundations needed to do this work are still sorely lacking While this may seem a dismal position the book is full of success stories such as the integrative approach of MuSIASEM Multi Scale Integrative Assessment of Social Ecological Metabolism developed by Mario Giampietro s group in Barcelona Spain the alternative perspectives of what Ariel Salleh calls the meta industrial discourse in Ecofeminism or the innovative trans departmental status of the Stockholm Resilience Centre in Sweden Putting both the theoretical and methodological challenges of moving beyond reductionism on the table for discussion this text aims to help a growing community of passionate thinkers and actors better understand themselves and their work

Ecological Systems Rik Leemans, 2012-12-12

Earth is home to an estimated 8 million animal species 600 000 fungi 300 000 plants and an undetermined number of microbial species Of these animal fungal and plant species an estimated 75% have yet to be identified Moreover the interactions between these species and their physical environment are known to an even lesser degree At the same time the earth s biota faces the prospect of climate change which may manifest slowly or extremely rapidly as well as a human population set to grow by two billion by 2045 from the current seven billion Given these major ecological changes we cannot wait for a complete biota data set before assessing planning and acting to preserve the ecological balance of the earth This book provides comprehensive coverage of the scientific and engineering basis of the systems ecology of the earth in 15 detailed peer reviewed entries written for a broad audience of undergraduate and graduate students as well as practicing professionals in government academia and industry The methodology presented aims at identifying key interactions and environmental effects and enabling a systems level understanding even with our present state of factual knowledge

Grassroots to Global Marianne E. Krasny, 2018-06-15 This edited volume presents diverse case studies about the implications of civic ecology practices worldwide It answers how civic ecology practices emerge the role the practices play in

the ability of communities and individuals to address social ecological stresses and given climate associated disturbances what strategies can be used to expand impacts of community driven practices to foster large scale resilience and sustainability

Complex Evolutionary Dynamics in Urban-Regional and Ecologic-Economic Systems J. Barkley Rosser, 2011-06-22 Drawing on the middle chapters from the first edition of J Barkley Rosser's seminal work *From Catastrophe to Chaos* this book presents an unusual perspective on economics and economic analysis Current economic theory largely depends upon assuming that the world is fundamentally continuous However an increasing amount of economic research has been done using approaches that allow for discontinuities such as catastrophe theory chaos theory synergetics and fractal geometry The spread of such approaches across a variety of disciplines of thought has constituted a virtual intellectual revolution in recent years This book reviews the applications of these approaches in various subdisciplines of economics and draws upon past economic thinkers to develop an integrated view of economics as a whole from the perspective of inherent discontinuity

**Discontinuities in Ecosystems and Other Complex Systems** Craig R. Allen, C. S. Holling, 2008-08-05 Following the publication of C S Holling's seminal work on the relationship between animal body mass patterns and scale specific landscape structure ecologists began to explore the theoretical and applied consequences of discontinuities in ecosystems and other complex systems Are ecosystems and their components continuously distributed and do they adhere to scaling laws or are they discontinuous and more complex than early models would have us believe The resulting propositions over the structure of complex systems sparked an ongoing debate regarding the mechanisms generating discontinuities and the statistical methods used for their detection This volume takes the view that ecosystems and other complex systems are inherently discontinuous and that such fields as ecology economics and urban studies greatly benefit from this paradigm shift Contributors present evidence of the ubiquity of discontinuous distributions in ecological and social systems and how their analysis provides insight into complex phenomena The book is divided into three sections The first focuses on background material and contrasting views concerning the discontinuous organization of complex systems The second discusses discontinuous patterns detected in a number of different systems and methods for detecting them and the third touches on the potential significance of discontinuities in complex systems Science is still dominated by a focus on power laws but the contributors to this volume are convinced power laws often mask the interesting dynamics of systems and that those dynamics are best revealed by investigating deviations from assumed power law distributions In 2008 a grand conference on resilience was held in Stockholm hosting 600 participants from around the world There are now three big centers established with resilience the most recent one being the Stockholm Resilience Center with others in Australia an international coral reef center Arizona State University's new sustainability center focusing on anthropology and Canada's emerging social sciences and resilience center Activity continues to flourish in Alaska South Africa and the United Kingdom and a new center is forming in Uruguay

Ecosystem-Based Management for the Oceans Karen McLeod, Heather



Leslie,2012-09-26 Conventional management approaches cannot meet the challenges faced by ocean and coastal ecosystems today Consequently national and international bodies have called for a shift toward more comprehensive ecosystem based marine management Synthesizing a vast amount of current knowledge Ecosystem Based Management for the Oceans is a comprehensive guide to utilizing this promising new approach At its core ecosystem based management EBM is about acknowledging connections Instead of focusing on the impacts of single activities on the delivery of individual ecosystem services EBM focuses on the array of services that we receive from marine systems the interactive and cumulative effects of multiple human activities on these coupled ecological and social systems and the importance of working towards common goals across sectors Ecosystem Based Management for the Oceans provides a conceptual framework for students and professionals who want to understand and utilize this powerful approach And it employs case studies that draw on the experiences of EBM practitioners to demonstrate how EBM principles can be applied to real world problems The book emphasizes the importance of understanding the factors that contribute to social and ecological resilience the extent to which a system can maintain its structure function and identity in the face of disturbance Utilizing the resilience framework professionals can better predict how systems will respond to a variety of disturbances as well as to a range of management alternatives Ecosystem Based Management for the Oceans presents the latest science of resilience while it provides tools for the design and implementation of responsive EBM solutions

A Framework of Human Systems Engineering Holly A. H. Handley,Andreas Tolk,2020-12-03 Explores the breadth and versatility of Human Systems Engineering HSE practices and illustrates its value in system development A Framework of Human Systems Engineering Applications and Case Studies offers a guide to identifying and improving methods to integrate human concerns into the conceptualization and design of systems With contributions from a panel of noted experts on the topic the book presents a series of Human Systems Engineering HSE applications on a wide range of topics interface design training requirements personnel capabilities and limitations and human task allocation Each of the book s chapters present a case study of the application of HSE from different dimensions of socio technical systems The examples are organized using a socio technical system framework to reference the applications across multiple system types and domains These case studies are based in real world examples and highlight the value of applying HSE to the broader engineering community This important book Includes a proven framework with case studies to different dimensions of practice including domain system type and system maturity Contains the needed tools and methods in order to integrate human concerns within systems Encourages the use of Human Systems Engineering throughout the design process Provides examples that cross traditional system engineering sectors and identifies a diverse set of human engineering practices Written for systems engineers human factors engineers and HSI practitioners A Framework of Human Systems Engineering Applications and Case Studies provides the information needed for the better integration of human and systems and early resolution of issues based on human constraints and limitations

**Governing Complex Systems** Oran R. Young, 2017-02-24 An exploration of the need for innovative mechanisms of governance in an era when human actions are major drivers of environmental change The onset of the Anthropocene an era in which human actions have become major drivers of change on a planetary scale has increased the complexity of socioecological systems Complex systems pose novel challenges for governance because of their high levels of connectivity nonlinear dynamics directional patterns of change and emergent properties Meeting these challenges will require the development of new intellectual capital In this book Oran Young argues that to achieve sustainable outcomes in a world of complex systems we will need governance systems that are simultaneously durable enough to be effective in guiding behavior and agile enough to adapt to rapidly changing circumstances While some insights from past research on governance remain valid in this setting Young argues that we need new social capital to supplement mainstream regulatory approaches that feature rule making with an emphasis on compliance and enforcement He explores the uses of goal setting as a governance strategy the idea of principled governance and the role of what is often called good governance in meeting the challenges of the Anthropocene Drawing on his long experience operating on the science policy frontier Young calls for more effective collaboration between analysts and practitioners in creating and implementing governance systems capable of producing sustainable outcomes in a world of complex systems

**New Advances in Information Systems and Technologies** Álvaro Rocha, Ana Maria Correia, Hojjat Adeli, Luis Paulo Reis, Marcelo Mendonça Teixeira, 2016-03-15 This book contains a selection of articles from The 2016 World Conference on Information Systems and Technologies WorldCIST 16 held between the 22nd and 24th of March at Recife Pernambuco Brazil WorldCIST is a global forum for researchers and practitioners to present and discuss recent results and innovations current trends professional experiences and challenges of modern Information Systems and Technologies research together with their technological development and applications The main topics covered are Information and Knowledge Management Organizational Models and Information Systems Software and Systems Modeling Software Systems Architectures Applications and Tools Multimedia Systems and Applications Computer Networks Mobility and Pervasive Systems Intelligent and Decision Support Systems Big Data Analytics and Applications Human Computer Interaction Health Informatics Information Technologies in Education Information Technologies in Radiocommunications

**The Cambridge Handbook of Environmental Justice and Sustainable Development** Sumudu A. Atapattu, Carmen G. Gonzalez, Sara L. Seck, 2021-04-01 Despite the global endorsement of the Sustainable Development Goals environmental justice struggles are growing all over the world These struggles are not isolated injustices but symptoms of interlocking forms of oppression that privilege the few while inflicting misery on the many and threatening ecological collapse This handbook offers critical perspectives on the multi dimensional intersectional nature of environmental injustice and the cross cutting forms of oppression that unite and divide these struggles including gender race poverty and indigeneity The work sheds new light on the often neglected social dimension of sustainability and its relationship to human

rights and environmental justice Using a variety of legal frameworks and case studies from around the world this volume illustrates the importance of overcoming the fragmentation of these legal frameworks and social movements in order to develop holistic solutions that promote justice and protect the planet s ecosystems at a time of intensifying economic and ecological crisis

**Research Handbook on Climate Change and Agricultural Law** Mary Jane Angelo, Anél Du Plessis, 2017-03-31 Research Handbook on Climate Change and Agricultural Law *Introduction to Civil Engineering Systems* Samuel Labi, 2014-04-07 This book presents an integrated systems approach to the evaluation analysis design and maintenance of civil engineering systems Addressing recent concerns about the world s aging civil infrastructure and its environmental impact the author makes the case for why any civil infrastructure should be seen as part of a larger whole He walks readers through all phases of a civil project from feasibility assessment to construction to operations explaining how to evaluate tasks and challenges at each phase using a holistic approach Unique coverage of ethics legal issues and management is also included

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