Preface

This book addresses recent technological progress that has led to an increased complexity in societal, ecological, and engineered systems. This complexity is characterized by the emergence of new proprieties and structures resulting from nonlinear interactions among system elements and between system and its environment. This volume provides researchers and managers with qualitative and quantitative methods, bottom-up and holistic approaches for handling many features of the complex contemporary reality. This book is composed of three parts with a total of 13 chapters: Part I (Chaps. 1–6) focuses on societal and ecological systems, Part II (Chaps. 7–12) deals with approaches for understanding, modeling, forecasting, and mastering complex systems, and Part III (Chap. 13) includes real-life examples. Each chapter of this book has its own special features; it is a self-contained contribution of researchers working in different fields of science and technology relevant to the study of complex systems including Agent-Based Modeling, General Systems Theory, and Mathematical Modeling.

In the chapter "ProtestLab: A Computational Laboratory for Studying Street Protests," Lemos, Coelho, and Lopes present an Agent-Based model for the simulation of street protests, with multiple types of agents (protesters, police, and "media") and scenario features (attraction points, obstacles, and entrances/exits). In this model agents can have multiple "personalities," goals, and possible states. The model includes quantitative measures of emergent crowd patterns, protest intensity, police effectiveness, and potential "news impact," which can be used to compare simulation outputs with estimates from videos of real protests for parameterization and validation. ProtestLab was applied to a scenario of policemen defending a government building from protesters and reproduced many features observed in real events, such as clustering of "active" and "violent" protesters, formation of moving confrontation lines, occasional fights and arrests, "media" agents wiggling around "hot spots," and policemen with defensive or offensive behavior.

In the chapter "A Generic Agent Based Model of Historical Social Behavior Change," Ahmed M'hamdi et al. describe and discuss how human societies change over time. The main objective of this work is to build a generic agent-based model of artificial social evolution in order to explore the East–West and North–South divides, the migration process, and some possible evolution ways.

In the chapter "Understanding Social Systems Research," Klein embarks on the challenge of social complexity. He illustrates how decomposing our notion of the social into political and cultural aspects improves our possibilities to understand social systems. The praxeological departure point of the chapter is the reception of the volatile, uncertain, complex, and ambiguous (VUCA) world in project management. Referring to the works of Niklas Luhmann the importance of meaning creation and sensemaking for social systems comes into sight. Leading from Systemic Inquiry to Systems Analytics, Klein describes the state of the art of social systems research and the implications for problem structuring and research design. Klein ends on a reflection on the necessity of systems literacy and social design impact evaluation as a way forward for the twenty-first century to become systems savvy.

In the chapter "ForestSim: An Agent-Based Simulation for Bioenergy Sustainability Assessment," Mark Rouleau proposes the use of Agent-Based Modeling (ABM) for bioenergy sustainability assessment. His study focuses on the assessment of second generation bioenergy from woody biomass as a potential renewable energy alternative to fossil fuels. He uses ForestSim, an ABM simulation to assess the sustainability of bioenergy development in the heavily forested region of the Upper Peninsula of Michigan, USA. He explains how ABM makes it possible to investigate bioenergy sustainability as a complex phenomenon that emerges within a coupled human and natural system. He compares the ABM simulation approach to conventional Life Cycle Assessment and explains why ABM is necessary to understand the complex dynamics of a bioenergy system. Finally, he compares his approach to an existing sustainability study in the UP with the goal of estimating biomass availability within the context of economic viability, ecological balance, and the social acceptance of bioenergy. He believes that his approach offers valuable insight into bioenergy sustainability and provides an important alternative assessment method.

In the chapter "Toward a Complex Concept of Sustainability," Humberto Mariotti examines the relationships between complexity theory and some situations not usually approached in the pertinent literature. One of the studied aspects is the need to insert human nature among the variables of the sustainability/complexity relationships as a way to "complexify" them, as well as to provide a kind of realism that is badly needed to work on complex issues. The complexity of human nature is studied from several perspectives. The chapter is closed with the presentation of what the author calls a complex concept of complexity.

In the chapter "Effects of Policy Decision-Making on Riparian Corridors in a Semi-Arid Desert: A Modeling Approach," Pope and Gimblett project the impact of an urban community on vegetation along the Upper San Pedro River. The riparian corridor is highly valued as important habitat in the American Southwest; nearly 57,000 acres of public land in the watershed are protected by Congress as a Riparian National Conservation Area. However, the corridor is at risk from extensive groundwater pumping to satiate growing urban demand. This work was designed to produce the potential effects of policy decision-making on riparian vegetation, including how much, where, and the likelihood of change occurring. A model was developed that combined both agent-based and Bayesian modeling techniques with three submodels: social, hydrological, and ecological. Using a variety of policy scenarios, the agent-based model predicted the percent change in vegetation area as well as the area the change is likely to occur while the Bayesian model produced likelihoods of change. The models were developed to be stakeholder-friendly, so that local decision-makers could use them to help make better decisions.

In the chapter "Dialectical Systems Theory as a Way to Handle Complex Systems," Matjaz Mulej et al. explain that complexity in natural, social, organizational, and technological phenomenon is hardly to be handled by the specialist vision unless one applies one or more of the versions of systems theory, which support interdisciplinary creative cooperation, such as the Dialectical Systems Theory. They also demonstrate that the related applied methodologies and methods are also very useful, because they can be used without too much complexity of theories, such as "Corporate Social Responsibility" (ISO 26000), "USOMID," "Six Thinking Hats" and their synergetic applications.

In the chapter "Reducing Complexity of Nonlinear Dynamic Systems," Nagy-Kiss et al. present a systematic procedure to transform a nonlinear system into a polytopic one without causing any information loss, contrarily to most existing studies in the field. They also present a robust observer synthesis with respect to internal/external perturbations, modeling parameterization errors, and unknown inputs for the estimation of the state variables. The above-mentioned points are applied to an activated sludge wastewater treatment plant, which is a complex chemical and biological process.

In his chapter "A Few Reflections on the Quality of Emergence in Complex Collective Systems," Vincenzo De Florio discusses the major factors that play a role in the persistence of emergence in collective systems. By means of those factors, a "general systems theory" of emergent systems is proposed. Several classes of emergent systems are then exemplified, ranging from simple aggregations of simple parts up to complex organizations of complex collective systems. The chapter also discusses the relationship between quality of emergence and resilience, namely the persistence of system identity. As suggested already by G. W. Leibniz, De Florio argues here that emergence and its quality may be better assessed by considering the interplay between intrinsic, extrinsic, and "social" aspects.

In the chapter "Link Structure Analysis of Urban Street Networks for Delineating Traffic Impact Areas," Wen et al. propose an innovative analytical procedure of ranking algorithm, the Flow-based PageRank (FBPR), for investigating the traffic flow concentration, complexity of street network structure, and traffic impact areas. A network modularity algorithm is used for delineating the traffic impact areas that will be affected by traffic congestion. The results indicate, by overlapping the topological structure of street network and flow concentration, street segments prone to traffic congestion are identified, including the Central Business Districts (CBD), and the areas proximate to the stations of the combination of MRT and train railway systems. Meanwhile, the delineation of traffic impact areas could be spatially targeted at priorities of traffic improvement for city planners.

In the chapter "Logic, Mathematics and Consistency in Literature: Searching for Don Quixote's Place," Montero et al. combine fuzzy logic with other techniques to analyze the consistency of the linguistic discourse about the village Miguel de Cervantes (1547–1616) decided not to reveal in his classical Don Quixote's novel. In particular, the authors consider Cervantes linguistic description of Don Quixote's trips from and to that place in order to check if such information is consistent with the map of La Mancha, and allowing a more or less constant walking speed march per day. From this complex system of information, it is then concluded that there is in fact a small region in the center of Campo de Montiel that meets all estimated walking times per day, showing that Cervantes linguistic description of the trips involving the hidden place is in this sense consistent.

In the chapter "Energy-Efficient Buildings as Socio-Technical Complex Systems: Approaches and Challenges," Lachhab et al. present important metrics that assess performance and occupants' comfort in energy-efficient buildings and study their relationships with building physical properties, equipment control, outdoor environment, and occupants' behavior and activities. The authors analyze occupants' actions and behaviors in context taking into account the complex interlinked entities, situations, processes, and their dynamics. Lachhab et al. then review existing control approaches and solutions for energy efficiency in complex buildings. They highlight simulation tools that aim to study and analyze approaches for energy consumption, occupants' comfort, and CO_2 emissions. They also introduce their ongoing work related to modeling and control of these complex systems by highlighting the necessity of the development of intelligent building management systems that could include run-time processing techniques of large amount of data for deploying context-aware event-triggered control techniques.

In the chapter "Modeling Space-Time-Action Modularity and Evolution of Living Systems," Pierre Bricage develops a new paradigm of "the gauge invariance of living systems" which allows him to define functionally and dynamically the hierarchical fractal organization of all living systems, from the quantum of Planck to the whole universe. The ontogeny of interactions and the interaction of ontogenies are topologically related through a power law of exponent 3/2, which is basically related to the Brownian motion. His work was motivated by the need to understand why all living systems are emerging through juxtaposition and embedment of previous ones in a new blueprint that is always an Association for the Reciprocal and Mutual Sharing of Advantages and Disadvantages: "interaction is construction and construction is interaction" both for the spaces and times, which are juxtaposed and embedded simultaneously into limited spatial and temporal networks, within an "independent of mass-entropy relationship inter-active optimal surface flow of flows" organizing control.

The editors would like to thank all the authors who contributed to this book. Special thanks also go to Mr. Christopher Coughlin and Mr. Abdeljalil Haib for their collaboration in this book project.

Agadir, Morocco Mohamed Nemiche
Rabat, Morocco Mohammad Essaaidi

Springer
http://www.springer.com/978-3-319-46163-2

Advances in Complex Societal, Environmental and Engineered Systems
Nemiche, M.; Essaaidi, M. (Eds.)
2017, XVI, 297 p. 74 illus., 47 illus. in color., Hardcover
ISBN: 978-3-319-46163-2