Principles for Building Resilience

Sustaining Ecosystem Services in Social–Ecological Systems

As both the societies and the world in which we live face increasingly rapid and turbulent changes, the concept of resilience has become an active and important research area. Reflecting the very latest research, this book provides a critical review of the ways in which the resilience of social–ecological systems, and the ecosystem services they provide, can be enhanced.

With contributions from leaders in the field, the chapters are structured around seven key principles for building resilience: maintain diversity and redundancy; manage connectivity; manage slow variables and feedbacks; foster complex adaptive systems thinking; encourage learning; broaden participation; and promote polycentric governance. The authors assess the evidence in support of these principles, discussing their practical application and outlining further research needs. Intended for researchers, practitioners and graduate students, this is an ideal resource for anyone working in resilience science and for those in the broader fields of sustainability science, environmental management and governance.

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To the legendary Ralf Yorque Jr for her ability to inspire us during the many surprises and ongoing development and change that such a project – and the world around us – inevitably entails.

Contents

Acknowledgements

This book is the product of a long-standing and rewarding collaboration among a group of young scholars who first connected in 2007 to form the Resilience Alliance Young Scholars (RAYS) network. The RAYS was initiated by the Resilience Alliance (RA, http://www.resalliance.org) to provide a space for young resilience scholars linked to the RA and other resilience research nodes around the world to come together and share ideas, and develop a next generation of internationally networked resilience scientists. At the time the first RAYS group was initiated, most of us were PhD students or just starting postdocs. Ultimately, this book and the opportunity to develop the RAYS would not have been possible without the foresight and support of the RA in creating this space, and co-funding a series of workshops at which we met, formed some wonderful friendships and had a fantastic lot of fun!

The RAYS first met face to face at the first ever Resilience conference held in Stockholm in April 2008: Resilience 2008 – Resilience, Adaptation and Transformation in Turbulent Times, hosted by the newly established Stockholm Resilience Centre in Sweden. At this workshop we agreed that we wanted to become 'guerrilla researchers' that took on big ideas and challenged established 'truths' in the social–ecological resilience field. This sentiment laid the foundation for a series of collaborative projects, including the one that eventually morphed into this book. Our appreciation goes to all the RAYS and senior RA members that were part of this first meeting, and provided the original inspiration for this book. A special thank you also to the Resilience Alliance Surprises Group (Steve Carpenter, Marten Scheffer, Frances Westley and Carl Folke) who provided further inspiration for this project through

discussions at a meeting in Uruguay in January 2009, which Reinette (Oonsie) Biggs attended.

The project first got underway through an online discussion amongst the RAYS following the 2008 meeting, which led to an idea for a paper that would critically review various 'propositions' (some of which had arguably attained a somewhat myth-like status) that have been put forward as important factors for enhancing resilience in social–ecological systems. Our idea was to dig in and find out just how important were factors like diversity and participation in building resilience. How much evidence was there really for these propositions? When and where, and in what forms did they really matter? We wanted to write the paper we wish we could have read when we entered graduate school, and hopefully help future students (including our own students!) get their heads around the huge cross-disciplinary and sometimes bewildering resilience literature.

A landmark event in the development of the paper, which was eventually published in *Annual Review of Environment and Resources* in November 2012, was a two-and-a-half-day 'mock-court' workshop that was held on Gabriola Island, Canada in September 2009 in conjunction with an RA science meeting. At that time we had ten draft principles, and a small team of authors were tasked with developing and presenting the 'defence case' for each principle. This 'testimony' by the RAYS 'expert witnesses' for each principle was then cross-examined at length by a senior member of the RA. Subsequently, the floor was opened to all participants for questioning, several of whom had been specifically appointed to act as 'devil's advocates' for the different principles. The feedback and input from those who acted as cross-examiners and devil's advocates was hugely valuable in refining the set of principles and providing a balanced, critical review of each, laying the foundation for both the paper and this book. We also thank all the RA and RAYS participants at the main RA science meeting who participated in the Delphi-like survey process we ran directly after the mock-court workshop to refine the set of principles we had presented. Together, these two processes were

key to settling on the seven principles presented in the paper and this book. A special and big thank you for the insights, time and effort contributed by the cross-examiners: Elinor Ostrom, Katrina Brown, Frances Westley, Per Olsson, Mike Jones, Line Gordon, Marty Anderies and Christo Fabricius. We also greatly appreciate the input of the RAYS members who acted as devil's advocates and discussants at this workshop (and provided some very good entertainment): Victor Galaz, Terry Iverson, John Parker, Beatrice Crona and Jacopo Baggio. Although none of the cross-examiners or devil's advocates were involved in the further development of the paper, many of these people were subsequently re-engaged in the process of developing this book. In fact, several of these folks already suggested at that time that the scope of the topic we are tackling is so huge that we should consider a book rather than a paper; however, we found this prospect much too intimidating to contemplate at that stage!

A second important point of feedback and critique on the paper was provided during a 1.5-hour session we ran at the Resilience 2011 conference, entitled Resilience Propositions on Trial. This session was modelled on the mock-court process we ran in Canada, but focused on just two principles: diversity and redundancy, and learning and experimentation. This time round we decided to go for more of a mix of RAYS and senior RA scholars on the defence and cross-examination teams. A special thank you to everyone who participated in this session, which evoked a great deal of laughter, and some wonderful play-acting! The cross-examiners included Graeme Cumming, Elinor Ostrom, Vasilis Dakos, Duan Biggs, Claudia Pahl-Wostl, Sander van der Leeuw, Mike Schoon and Maja Schlüter; the defence team members were Brian Walker, Garry Peterson, Karen Kotschy, Shauna BurnSilver, Reinette (Oonsie) Biggs, Paul West, Frances Westley, Katrina Brown, Anne Leitch, Louisa Evans, Samantha Stone-Jovicich and Lisen Schultz; and the devil's advocates included Terry Iverson and Chanda Meek. Serendipitously, this session was attended by one of the conference's keynote speakers, Professor William Clark of Harvard University, USA. He was very

supportive of the more reflective, critical stance adopted in our project, and invited us to submit a proposal to *Annual Review in Environment and Resources*, which a small team of us cobbled together there and then. After which started the hard work – and many fun exchanges – to whittle down what had become a short monograph on each principle into a coherent paper.

By the time we submitted the paper, we had come to the realization that a book was not such a bad idea after all, and that in fact we already had much of the material for it. More importantly, in the course of developing the paper, we had fleshed out a shared conceptual framework and approach that could make for a really coherent, integrated, multi-author book. We also realized that developing such a product could provide a valuable opportunity for facilitating more interaction between the RAYS and the RA. We therefore invited a number of additional folks as authors on the book to help further broaden and solidify our review. That is the product you now hold in your hands. A big thank you to Dominic Lewis, Megan Waddington and Renee Duncan-Mestel at Cambridge University Press for guiding us through this process. Much thanks and appreciation also to Linda Luvuno for helping ensure that all the chapters and references were consistently formatted, and lending a friendly helping hand with many aspects of the final manuscript preparation. A big thanks to Jerker Lokrantz at Azote Images for so beautifully preparing all the figures for the book. Many authors also put effort into providing detailed review comments; the contribution of this to the internal consistency and quality of the book are much appreciated. In particular we thank Duan Biggs, Line Gordon and Louisa Evans for comments on Chapter 2, Ciara Raudsepp-Hearne, Victor Galaz and Shauna BurnSilver (Chapter 3), Karen Kotschy, Paul West and Marty Anderies (Chapter 4), Karen Kotschy, Vasilis Dakos and Garry Peterson (Chapter 5), Line Gordon, Jacopo Baggio, Anne Leitch and two external reviewers from CSIRO in Australia, Elizabeth Hobman and Rod McCrea (Chapter 6), Duan Biggs and Allyson Quinlan (Chapter 7), Örjan Bodin and Mark Reed (Chapter 8), Marty Anderies,

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Given the large number of authors involved and the early phases of many of their careers, a large variety of funding streams supported the development of this book. Without this support, and the freedom it gave us to pursue ambitious guerrilla-type research topics, this book would not have materialized. Reinette (Oonsie) Biggs was supported through a Centre of Excellence grant by the Swedish Research Council Formas, a Branco Weiss Society in Science fellowship and a fellowship from the Stellenbosch Institute for Advanced Study (STIAS) during the course of coordinating the paper and this book. Maja Schlüter was supported by a Branco Weiss Society in Science fellowship and acknowledges the Project Besatzfisch funded by the German Ministry of Education and Research in the Program for Social–Ecological Research (grant 01UU0907), and a grant by the European Research Council under the EU FP7 (FP/2007–2013)/ERC grant agreement no. 283950 SES-LINK. J. Marty Anderies gratefully acknowledges support from the US National Science Foundation grant numbers SES-0645789 and GEO-1115054. Derek Armitage's research is supported by ArcticNet and by the Social Science and Humanities Research Council of Canada. Jacopo A. Baggio acknowledges a postdoctoral fellowship from the Center for the Study of Institutional Diversity at Arizona State University and support from NSF grant GEO-1115054. Elena Bennett was supported by the National Science and Engineering Research Council (NSERC) Discovery. Örjan Bodin acknowledges support from the strategic research programme Ekoklim at Stockholm

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Lastly, a big thank you to all our readers – including graduate students, fellow researchers and practitioners. Ultimately, it was the idea that you might find a synthesis like this useful and insightful in helping guide actions towards building a better world that gave us the inspiration and energy to put this book together. We hope it lives up to this!

Foreword

Why should we care at all about resilience? The biosphere – the sphere of life – is the living part of the outermost layer of our rocky planet, the part of the Earth's crust, waters and atmosphere where life dwells. It is the global ecological system integrating all living beings and their relationships. Humans are embedded parts of the biosphere and shape it, from local to global scales, from the past to the future. At the same time humans are fundamentally dependent on the capacity of the biosphere to sustain development. Humanity is indeed an embedded part of the biosphere shaping and reshaping its environment. In this sense humanity co-evolves with the planet and our beliefs, perceptions, choices and actions shape our future in the biosphere. Fundamental issues for humanity like democracy, health, poverty, inequality, power, human rights, security and peace all rest on the life-support capacity and resilience of the biosphere.

The situation of the Anthropocene – where the biosphere is shaped by humanity from local to global levels – reinforces that there are no ecosystems without people and no human development without support from the biosphere, hence, social–ecological systems. Humans and nature are truly intertwined and ecosystem services are critical for well-being. Analysing the world from historical, economic, geographical, ecological or other disciplinary approaches will provide bits of the puzzle. But, in the Anthropocene, the scale, speed and connectivity of human actions interact with the dynamics of the Earth system in new ways, which call for new understanding, new integrated approaches and collaborations across disciplines. Analysing situations of incremental change and assuming a stable environment is no longer the most fruitful way to understand the world and improve the human predicament. Viewing the world as a

complex system is a more recent and promising approach that is emerging across the disciplines, including social and natural sciences as well as the humanities, and also the foundation of this book.

Reinette (Oonsie) Biggs, Maja Schlüter and Michael Schoon have done an excellent job pushing the frontier of sustainability science and resilience thinking by orchestrating the inspiring chapters of *Principles for Building Resilience: Sustaining Ecosystem Services in Social–Ecological Systems* into a coherent and significant book. The book has the biosphere and a complex systems approach as the foundation for understanding social–ecological systems and resilience.

Resilience as used here is about having the ability to live with change, and develop with it. It is about cultivating the capacity to sustain development in the face of change, incremental and abrupt, expected and surprising. Resilience is about persisting with change on the current path of development, improving and innovating on that path. Sometimes actions lead to path dependency and to traps that are difficult to get out of. The resilience of the system has become too robust and too rigid. In such situations the challenge is to reduce resilience and try to shift away from the current path into new ones. Sometimes those shifts may be smooth, other times revolutionary.

Shifts between states and development pathways are at the core of resilience research. In research on social–ecological systems and resilience, adaptation refers to human actions that sustain development on the current pathway, while transformation is about shifting development into new pathways and even creating new pathways. Deliberate transformation involves breaking down the resilience of the old and building the resilience of the new. A shifting pathway does not take place in a vacuum. It draws on resilience from multiple scales and diverse sources, making use of crises as windows of opportunity, recombining experience and knowledge, learning with change, and governing transformations for innovative pathways in tune with the resilience of the biosphere.

This is the very focus of *Principles for Building Resilience: Sustaining Ecosystem Services in Social–Ecological Systems*. The book investigates a set of propositions for general features of resilience in relation to uncertainty. It is about how to deal with an uncertain future in relation to diverse pathways, and thresholds and tipping points between them. The authors expand on the significant paper 'Toward principles for enhancing the resilience of ecosystem services', which was published in *Annual Review of Environment and Resources* in 2012, led by Reinette (Oonsie) Biggs and Maja Schlüter. The paper identified seven generic principles for enhancing the capacity of social–ecological systems to continue delivering desired sets of ecosystem services in the face of disturbance and ongoing change:

- maintain diversity and redundancy;
- manage connectivity;
- manage slow variables and feedbacks;
- foster an understanding of social–ecological systems as complex adaptive systems;
- encourage learning and experimentation;
- broaden participation; and
- promote polycentric governance systems.

It then critically reviewed evidence in support of each of these principles. In doing so, the paper attempted to bring together some very different strands of resilience research, specifically in relation to the implications of the findings for managing ecosystem services.

The book is a major and comprehensive extension of the insights and findings of the general resilience principles paper. It brings together different disciplinary traditions and strands of resilience work in an interdisciplinary and coherent way. The authors, engaged with research groups, centres and institutes of the Resilience Alliance, have operated as a team, developing a common conceptual framework and approach to a deep investigation of the principles.

Work on resilience has exploded in the last decade. Resilience is used in many different areas and disciplines and sometimes interpreted

in ways to fit old paradigms and discourses. In contrast, what is beautiful here is that the foundation of this book recognizes that humanity is an embedded part of the biosphere and is dependent on its life-supporting environment generating essential ecosystem services as a precondition for societal development and progress. It is explicit about the challenges of the Anthropocene, with human well-being and ecosystem service trade-offs occurring across spatial and temporal scales, being co-produced by social–ecological systems, and accounting for issues of power and equity in this context. In particular, given the proliferation of resilience-related research the attempt to systematically assess and critically evaluate empirical evidence in support of the seven propositions and claims that have been put forward as underlying principles for building resilience in social–ecological systems is of great value.

The turbulent times in which we live open up space for new ways of thinking and action that take complexity seriously. This book is a manifestation of the situation, with authors collaborating in and integrating diverse disciplines and knowledge systems, and taking on the search for understanding the complexity and dynamics of social–ecological systems together with the challenges of biosphere stewardship. The book provides an exciting, coherent and in-depth review of the state of understanding on how different key factors affect the resilience of social–ecological systems. It nicely discusses the practical application of these principles and lays out further research needs in relation to managing and governing ecosystem services for human well-being. It is an excellent contribution to the frontier of resilience research and sustainability science. Every chapter is worth diving deep into, reflecting upon and rethinking. The book will no doubt be a source of inspiration for many.

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