

World Sustainability Series

Walter Leal Filho
Robert W. Marans
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Handbook of Sustainability and Social Science Research

 Springer

World Sustainability Series

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Handbook of Sustainability and Social Science Research

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Preface

Many scholars perform high-quality research on matters related to sustainability. Yet, there are relatively few events where a multidisciplinary overview of research efforts and projects has taken place, and where research scholars from across the spectrum of the social sciences have had the opportunity to come together to discuss research methods, research findings, or exchange ideas about ongoing and future research opportunities focusing on sustainability.

It is against this background that the “Sustainability and Social Science Research Symposium” was organized by the University of Michigan, in cooperation with the Inter-University Sustainable Development Research Programme (IUSDRP), Manchester Metropolitan University, HAW Hamburg and a number of institutions of higher education active in this field.

The aims of the symposium were as follows:

- i. to provide social science researchers focusing on sustainability an opportunity to present and discuss their work (e.g., empirical work, case studies, teaching and learning innovations, applied projects, etc.);
- ii. to foster the exchange of information, ideas, and experiences acquired in the execution of research projects, especially initiatives which have influenced behavior, decision-making, or policy;
- iii. to discuss methodological approaches and projects which aim to offer a better understanding of sustainability across society and economic sectors; and
- iv. to network the participants and provide a platform so they can explore possibilities for further cooperation.

Last but not least, a further aim of the event was to document and disseminate the wealth of experiences on sustainability and social science research. To that end, this peer-reviewed “Handbook of Sustainability and Social Science Research” has been produced. The publication introduces the results of research, field studies, and projects around social science research on matters related to sustainability, and introduces new and innovative thinking on how social sciences influence sustainability and vice versa.

The book is structured in three main parts. Part I explores the connections between sustainability and the social sciences. It includes discussions of key paradigms and analytical concepts, explores policy applications, and considers new approaches to education and economics. Part II highlights research and findings from an array of behavioral interventions and participant engagement efforts covering topics such as climate change, resource conservation, renewable energy, social justice, and green citizenship. Part III provides several examples of innovative methodological approaches and evaluation strategies such as cognitive mapping, brainstorming, online surveys, instructional modules, and sustainability assessments.

We thank the authors for their willingness to share their knowledge, know-how, and experiences, as well as the many peer reviewers, which have helped us to ensure the quality of the manuscripts. We also thank Dr. Mihaela Sima for her hard work and for all her help in the organization of the event and production of this book.

Enjoy your reading!

Hamburg, Germany/Manchester, UK
Ann Arbor, USA
Ann Arbor, USA
Winter 2017/2018

Walter Leal Filho
Robert W. Marans
John Callewaert

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Part I
**Exploring the Connections: Sustainability
and Social Science Research**

Interplays of Sustainability, Resilience, Adaptation and Transformation

Jennifer L. Johnson, Laura Zanotti, Zhao Ma, David J. Yu,
David R. Johnson, Alison Kirkham and Courtney Carothers

Abstract

This chapter analyzes the complex interplays between and among *sustainability*, *resilience*, *adaptation* and *transformation*, key paradigms and analytical concepts that have emerged from the human-environmental interactions, social-ecological systems, and global environmental change literatures. Specifically, this chapter provides a summary of how these key paradigms and analytical concepts have evolved over time and synthesizes current debates about their interplays. Our findings reveal certain theoretical synergies between and among *sustainability*, *resilience*, *adaptation* and *transformation*, as well as epistemological tensions and practical tradeoffs when actions are taken to promote ostensibly desirable attributes of social-ecological systems through on-the-ground actions. These findings highlight the need for scholars, practi-

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tioners and policy makers to be explicit about the normative assumptions associated with *sustainability*, *resilience*, *adaptation* and *transformation* as they complement or contradict each other in local contexts, and how they may affect or be affected by the characteristics of and processes within local communities. Such understanding will be crucial for moving towards developing adaptation or transformation interventions that maximize the achievement of sustainability or resilience policy goals and minimize potential negative outcomes on both human well-being and environmental conditions.

1 Introduction

In recent decades, *sustainability* and *resilience* have emerged as two key paradigms within human-environmental interactions, social-ecological systems, and global environmental change literatures. From the 1987 Brundtland Report on Sustainable Development to the recent formulation of Sustainable Development Goals in a 2015 United Nations (UN) resolution, sustainability has become central to many international development policies and programs. A parallel development can be seen with respect to resilience, another key paradigm that has guided the international development communities arguably since the 1980s (Brown 2014). More recently, scholars, development practitioners and policy makers have paid more attention to the synergies between sustainability and resilience. This is evidenced in the final report of the 2010 UN High-Level Panel on Sustainability, entitled “Resilient People, Resilient Planet” (Galaz et al. 2012), and the 2016 International Union for the Conservation of Nature (IUCN) World Conservation Congress Hawai’i Commitments, which call for the promotion of sustainable livelihoods through improving ecosystem resilience. Beyond conservation, there is a growing desire within the global policy community to formulate science-based, multi-scalar, multi-faceted, and holistic solutions to global challenges in general (Biermann 2014; Galaz et al. 2012; Saunders 2015). Such desire has supported the rapid development of funding calls, interdisciplinary centers, and synergistic activities worldwide that rely on sustainability and resilience as two theoretical paradigms within which global challenges are described, understood, analyzed, and addressed.

Related to the paradigms of sustainability and resilience are *adaptation* and *transformation*, two key analytical concepts nested within them, and the associated capacities (*adaptability* and *transformability*) of actors in a social-ecological system that influence *adaptation* and *transformation* processes (Walker et al. 2004). As global environmental change, particularly climate change, becomes an increasingly visible area of concern in the scholarly, policy and public domains, the academic literature on adaptation to climate change and global environmental change in general has proliferated over the past 30 years. Specifically, a growing amount of work in this area focuses on the vulnerability, adaptive strategies, and adaptive

capacity of rural, and more recently urban communities, in both the Global North and Global South (Burnham and Ma 2016; Eakin et al. 2017). Adaptation as a policy goal has also been largely incorporated into development initiatives worldwide by various government agencies and international organizations (Conway 2011). However, as communities around the world increasingly face unprecedented changes, some scholars have argued that adaptation within current social-ecological systems along may not be sufficient to effectively address global environmental change (Colloff et al. 2017; Gillard et al. 2016). Instead, these scholars argue that transformational changes may be needed to enable current social-ecological systems to shift to different kind of systems, or to create fundamentally new systems altogether (Gillard 2016; Pelling et al. 2015; Redman 2014; Walker et al. 2004). Despite these debates about the hierarchical relationship between adaptation and transformation, both concepts have been used to guide policy actions for achieving sustainability and resilience goals.

Within these scholarly and policy contexts, this article provides a summary of how the key paradigms and analytical concepts of *sustainability*, *resilience*, *adaptation* and *transformation* have evolved over time; synthesizes the current debates about the interplays between and among these paradigms and concepts; charts the synergies and contradictions between and among these paradigms and concepts; discusses future directions for defining and achieving desired change; and, identifies the associated challenges and opportunities within both scholarly and policy domains. Importantly, recent scholarly discussions have identified power dynamics and epistemological frictions as underexplored and undertheorized areas in human-environmental interactions, social-ecological systems, and global environmental change literatures (Brown 2014; Cote and Nightengale 2012). Drawing from these critiques, in this chapter we consider how analyzing synergies and contradictions can further reveal tensions between normative and descriptive dimensions of these key paradigms and analytical concepts, which often become particularly noticeable when applying them to address real-world problems. Explicitly considering the normative dimensions of *sustainability*, *resilience*, *adaptation* and *transformation* enables us to better understand the applications and limitations of these key paradigms and analytical concepts, identify opportunities for improving interdisciplinary collaborations, and consider different approaches to minimize unintended policy and program outcomes. It further allows us to demonstrate the dominance of sustainability science and resilience thinking in human-environmental interactions, social-ecological systems and global environmental change literatures, and suggests that neither *sustainability* nor *resilience* should be considered the universal paradigm within which adaptation and transformation can be understood and applied.

2 Overview of Paradigms and Concepts

2.1 Sustainability as a Paradigm and Policy Goal

Once a fairly radical notion, sustainability is now a mainstream paradigm invoked by scholars, activists, governments and multi-national corporations alike. Sustainability as a site of global concern emerged in the second half of the 20th Century alongside growing recognition of the detrimental environmental and human-health impacts associated with industrial growth in the Global North, as well as growing economic inequalities between the industrialized and less-industrialized nations in the Global South. The notion was first popularized in the then-controversial Club of Rome report, *The Limits to Growth* (Meadows et al. 1972), which articulated the existence of ecological limits to population and economic growth. This report called for transformative change—both in ideology and in practice—to sustain humanity at large into the future. The most frequently cited definition of sustainability in contemporary scholarly and policy-based literatures is a definition of a different term altogether: sustainable development. The 1987 Brundtland Commission report defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED 1987). Less quoted is the second part of this definition, which identifies two key concepts and further integrates a needs-based approach within the core features for sustainable development: “the concept of ‘needs’, in particular the essential needs of the world’s poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment’s ability to meet present and future needs” (WCED 1987).

The term sustainability is now so ubiquitous across social, environmental and economic domains as to seemingly no longer require definition for operationalization. The ubiquity of sustainability invites competing interpretations and has generated numerous quantitative approaches for measuring the sustainability of a given system, making it difficult to evaluate the success or failure of sustainability-focused policies and programs due to a lack of consensus on measurement criteria. Although the flexibility of the term may have contributed to an increase in the number, diversity and scope of actors and domains of application, it has garnered critique for resulting in little more than “a listing of any societal objectives that agents happen to think important” (Brand and Jax 2007), leading some scholars to declare the end of its usefulness altogether (Benson and Craig 2014). Popular and widespread approaches to sustainability also tend to equate sustainability with sustainable development (Gonzalès and Parrott 2012; Walker et al. 2006). For example, Derissen et al. (2011, p. 1121) describes sustainability as capturing “basic ideas of intergenerational justice when human well-being depends on natural capital and services.” As such, sustainability seems to be uncritically commensurate with economic growth and market-based approaches to conservation. Further, Derissen et al.’s description of sustainability overlooks the portion of the Brundtland definition that draws attention to present-day global inequalities.

Instead, this definition privileges an undifferentiated approach to “human well-being” that fails to acknowledge power relations or intragenerational justice concerns. In other words, the ubiquity of a generalized definition of sustainability and sustainable development has important implications for how the Global North and the Global South are treated at sites of global governance and, relatedly, their ability to address sustainability and sustainable development.

In addition to increased acceptance of the paradigms of sustainability and sustainable development, sustainability has also been generally accepted as a normative concept from its induction (Anderies et al. 2013; Derissen et al. 2011; Hicks et al. 2016), that is, sustainability is a good thing that individuals and institutions ought to strive to foster. From this perspective, sustainability is characterized more as a process, as well as a policy goal (Berkes et al. 2003). For example, Eakin et al. (2017, p. 186) redefines sustainability as a “normative decision process involved in steering a system to a preferred state.” We find the normative assumptions associated with sustainability coupled with the increasingly widespread appeal of sustainability as a policy goal problematic. When sustainability is assumed to be a good thing and is uncritically embraced, important questions about who and what will be sustained, how sustainability will be operationalized on the ground, and what other short- and long-term outcomes that communities might desire, may be overlooked.

Despite criticisms of the utility of sustainability as a policy goal, initiatives promoting sustainability and sustainable development remain widespread, and different interpretations and applications of sustainability and sustainable development continue to emerge. For example, sustainability science is a research framework developed in the early 2000s, in part, as a reaction to the emerging prominence of sustainability and sustainable development as a dominant paradigm, and as a response to the need to develop an approach that “transcends the concerns of its foundational disciplines and focuses instead on understanding the complex dynamics that arise from interactions between human and environmental systems” (Clark 2007, p. 1737). Importantly, as noted above, sustainability, writ large, was not originally tied to notions that necessitate development or growth, and sustainability science scholars sought to return to the definition of the capacity of a system to persist in time (Costanza and Patten 1995).

And yet, the widespread resonance of the paradigm and its internalization in a variety of scholarly and applied domains have not resulted in the kind of transformative change that was initially considered necessary to achieve sustainability, as described in the Club of Rome report. Indeed, the very same institutions that were first held up as culpable for their unsustainable practices have successfully internalized criticisms and remolded themselves as working at the vanguard of environmental sustainability, including the private sector and international financial institutions (Benson and Kirsch 2010; Goldman 2006). The underlying drivers of sustainability challenges—for example, increasing use of fossil fuels, seemingly unending consumer demand, the rising production of less durable goods, and growth in the global economy overall—have not been sufficiently addressed. Sustainability in global environmental governance and policy worlds is carried out mostly as business as usual. Sustainable development, widely embraced, tends to narrow the focus on

intergenerational equity (rather than intragenerational), and as a policy mechanism, tends to obscure attention to equity, power and justice which were initially central concerns of early proponents of sustainability itself (Agyeman et al. 2002).

2.2 Resilience as a Paradigm and Policy Goal

Resilience, like sustainability, has become a commonplace term and paradigm from which to consider planetary concerns. Resilience thinking, resilience theory, or resilience paradigm refers to a cluster of concepts related to multiple stable states of self-organized systems and the interplay of persistence and reorganization involving these system states (Carpenter and Brock 2008, Duit et al. 2010). Resilience thinking was seeded in the field of ecology through the seminal work of Holling (1973; “ecological resilience”) and has been popularized over the last 20 years through the subsequent works of scholars who advocate a social-ecological systems approach that encompasses a resilience conceptual framework and adaptive cycle metaphor (Folke 2006; Gunderson and Holling 2002; Gotts 2007; Walker et al. 2004). Resilience in this context reflects the amount of shock a system can absorb without flipping into an alternate regime or stability domain (Barnett 2001; Folke 2006; Perrings and Brock 2009). A related conceptual framework was developed independently in the field of engineering with a focus on how built systems and environments can be designed to reduce the sensitivity of their performance to perturbations. Specifically, resilience in this context (i.e., “engineering resilience”) was traditionally focused on the rate of recovery or speed of bouncing back to a single stable state that a system is designed to exhibit after experiencing a perturbation (Bergen et al. 2001; Holling 1996; Hollnagel et al. 2006; Pimm 1984).

Over time, discussions about resilience in both contexts have been evolving, starting in the social-ecological systems literature and later in the built environment literature (Folke et al. 2003, 2004; Haigh and Amarutunga 2010). Specifically, engineers from different disciplines have recently recognized that resilience goes beyond the initial ‘bounce back’ and singular equilibrium state (Davoudi 2012). Some have further argued for tiered definitions of resilience (Anderies 2014; Hassler and Kohler 2014a; Moffatt 2014). For example, at the systems scale, resilience “offers a means to address the long-term evolution of the built environment” (Hassler and Kohler 2014b, p. 121) which allows effective conceptualization of adaptation and transformation of built environments; while at the scale of physical infrastructure, resilience is better used as a design principle (e.g., Boshier and Dainty 2011; Coaffee 2008; Hollnagel et al. 2006) which addresses “timescales and redundancy” (Hassler and Kohler 2014b, p. 121) and provides “clear feedback on its performance to allow for learning and adjustment” (Hassler and Kohler 2014b, p. 123).

Before such developments in the built environment literature, social-ecological systems scholars first started incorporating new approaches to modeling ecosystems, moving away from a single equilibrium approach to a non-linear model and emphasizing the temporal and spatial dynamics that often unfold across periods of change and the critical transitions among multiple stable states (Folke 2006). In this

paradigm, a resilient social-ecological system is one that has the capacity to absorb disturbance and experience shocks while retaining essentially the same function, structure, feedbacks, and therefore identity, through reorganization (Walker et al. 2004, 2006). In other words, resilience is achieved through adapting or transforming in response to social-ecological change in ways that strive to support or continue to support human well-being (Biggs et al. 2015; Chapin et al. 2010; Hassler and Kohler 2014b). Moreover, resilience can be further classified into general resilience and specified resilience (Folke et al. 2010). General resilience refers to the general capacity of a system to deal with both expected and unexpected disturbances. Hence, a system's ability to adapt or transform in response to social-ecological change and uncertainty is an important indicator of general resilience. Specified resilience, in contrast, focuses on the capacity of a system to maintain a specific function in relation to a set of disturbances. The perspective of specified resilience is embodied by the three core questions that one should ask in a resilience framework: resilience *of what*, resilience *to what*, and resilience *for whom* (Carpenter et al. 2001; Lebel et al. 2006). These three questions demand an analyst to be explicit about the potential tradeoffs involved in taking a resilience approach. That is, decisions about making x resilient to y because this matters to stakeholder group z must be made ahead of time. However, such decisions may potentially privilege some stakeholders over others, or cause the system to be more vulnerable to a different set of disturbances (Ingalls and Stedman 2016). Although the concept of resilience per se does not address normative considerations (i.e., a system state, whether good or bad to human well-being, can still be resilient), managing for specified resilience necessarily involves making normative decisions—the resilience of x to y for group z is a good thing and preferred over the resilience of p of q for group r .

The resilience paradigm has gained traction as a framework enabling the integration of social, economic, ecological and other considerations into conceptualizing pressing planetary problems and as a systems-based approach to modeling and managing human-environmental relations (Liu et al. 2007). Like sustainability and sustainable development, resilience thinking has been incorporated in key sites of policy making and decision making, most importantly the UN Framework Convention on Climate Change. Resilience thinking also circulates in other international, national, subnational and community-level policy processes and goals. For example, the 2014 Intergovernmental Panel on Climate Change conceptualized a resilient system not only as “the capacity of... systems to cope with a hazardous event or trend or disturbance... in ways that maintain their essential function, identity, and structure” but also as a system that maintains “the capacity for adaptation, learning, and transformation” (Xu et al. 2015, p. 2).

On the practical side, scholars and policy makers employ resilience as an analytical tool for identifying changes taking place in a complex system, describing key interactions among actors at different scales, and quantifying system attributes that are important for the functioning of the system, enabling the development of simulation models and decision-support tools that facilitate dynamic, adaptive management rather than static optimization (Fiksel 2006; Park et al. 2013; Thapa et al. 2010). This resilience-based analytical tool has been applied to understanding

ecosystem degradation (e.g., Hughes et al. 2010; Silliman et al. 2012); water management in agricultural, peri-urban, and urban landscapes (e.g., Gordon et al. 2010; Muller 2007; Wardekker et al. 2010); catastrophe management and disaster recovery (e.g., Adger et al. 2005; Park et al. 2013; Zhou et al. 2010); and a variety of other global challenges (Falkenmark and Rockström 2010; Speranza et al. 2014).

Despite its popularity and advancements over time, the resilience paradigm has been critiqued on a variety of fronts. Most prominently, the resilience paradigm is considered by some scholars to be “anti-social” because of its perceived failure to incorporate meaningful considerations of the dynamic nature of social systems, despite the growth of literatures addressing the complexity of coupled human and natural systems and of social-ecological changes (Cote and Nightingale 2012, p. 476). Specifically, the different and often competing definitions of and approaches to resilience arguably warrant attention (Cote and Nightingale 2012). As the concept of resilience has expanded into interdisciplinary circles and attempted to include and incorporate socio-cultural factors, it has faced consistent criticisms within the social sciences and humanities (Olsson et al. 2015) as well as within conservation biology (Newton 2016). Attempts at modeling social systems require data that capture cross-scale linkages, emergent properties, non-linear dynamics and uncertainty within social systems, which is generally lacking, as well as the incorporation of social, political and cultural variables that are methodologically complex and mathematically sophisticated (Domptail et al. 2013; Kottack 1999; Leenhardt et al. 2015). Consequently, modeling social systems proves challenging and often ineffective in capturing social dynamics in a robust and rigorous way. Despite concerted efforts to engage in analyses of social systems, such as those presented by the Resilience Alliance, there are persistent difficulties associated with translating findings in anthropology and allied disciplines into applied contexts, and with reluctance among scholars and practitioners to do this in the first place (Kottack 1999; Olsson et al. 2015).

The work of Elinor Ostrom, Fikret Berkes, Johan Colding, Carl Folke, those involved in the Resilience Alliance, and others has sought to develop and enhance the social-systems aspect of resilience thinking, especially in relationship to governance and the policy dimensions of resilience (e.g., Anderies et al. 2004, 2013; Berkes et al. 2003; Berkes and Folke 1998; Boyd and Folke 2012; Folke et al. 2010; Ostrom and Janssen 2005; Partelow 2016). Although much scholarship on social-ecological systems has been produced, tensions regarding the conceptual flexibility of resilience among scholars and policy makers who embrace resilience still persist. On one hand, many scholars find that flexibility and conceptual vagueness undermine the practical application of resilience, making it difficult to incorporate concerns of equity, power and justice into the development of models that describe the complexity of social-ecological systems. On the other hand, the conceptual flexibility is seen by many as necessary for advancing interdisciplinary research and collaboration in specific contexts (Strunz 2012).

2.3 Adaptation and Transformation: Continuum or Dichotomy?

Adaptation and transformation are often used to describe means to achieve sustainability or resilience goals. Empirically, analyses of adaptation have mainly focused on individual agents and groups, whereas analyses of transformation have mainly focused on systems as bounded or nested wholes. Generally speaking, both concepts refer to some kind of adjustments or changes in a system's structure, function or processes to cope with internal and external stressors. Such adjustments or changes include but are not limited to the adoption of new management practices or technologies, formation of new governance systems or institutions, shifts in cultural values, and relocation. Distinctions between whether a given adjustment or change is defined as an adaptation or transformation hinge on whether adjustments allow a system to retain core system functions and characteristics (adaptation) or shift into a new system altogether (transformation). In other words, whether an actual or proposed adjustment or change is considered adaptation or transformation depends on what boundaries analysts have conceptually drawn around a given system, what components they determine to be relevant, and what scales they use for their analyses (Anderies et al. 2013). For example, transformation could imply multiple, evolving adaptation processes at various scales (O'Brien et al. 2015), while others argue that managing a complex system may require transformation of sub-systems thus transformation can also be an essential part of a complex system's adaptive response to change (Rickards 2013).

Adaptation research has a long history with a particular focus on how human communities respond to ongoing environmental change, particularly climate change. Starting in the 1980s, scholars began to examine how agricultural producers deal with climate variability, particularly in non-industrialized nations. Since the 2000s, adaptation to climate variability and change has been formally incorporated into agricultural and international development programs worldwide (Burnham and Ma 2016). The integration of adaptation in agricultural research and agriculture-oriented development programs is not singular; this is reflective of similar trends that have taken place within scholarship on forestry management and fisheries (e.g., Adger 2000; Adger et al. 2001; Bele et al. 2013; Davidson et al. 2003; Keenan 2012; Kelly and Adger 2000; Miller et al. 2010a).

While adaptation was initially conceptualized as behavioral response to environmental change, framing of adaptation has evolved within the scholarly literature to mean a process of reducing vulnerability, and more recently a pathway of change and response (Burnham and Ma 2017; Fazey et al. 2016; Pelling 2011; Wise et al. 2014). Despite these conceptual developments, so far the majority of empirical research on adaptation has treated adaptation as incremental behavioral response to proximate causes of vulnerability (Burnham and Ma 2016). Current adaptation policies also tend to focus on reactive, local, short-term adaptations, and are generally ineffective in promoting practices and structural changes necessary for adapting to long-term environmental change and various uncertainties (Colloff et al. 2017; Stafford Smith et al. 2011). Opponents of this behavioral approach to

adaptation argue that changes in global environmental conditions and social goals are likely to transform social-ecological systems in ways that are unprecedented and unpredictable to scholars and policy makers (Nelson et al. 2007; Wise et al. 2014). Thus, viewing adaptation as part of pathways of change and response will better enable understanding of various forms of uncertainty, risk and opportunity facing individuals, groups and communities, and can produce insights important for developing and implementing adaptation interventions that allow people to manage multiple stressors simultaneously (Burnham and Ma 2017). This emerging discussion about adaptation pathways is also linked to an increasing attention to the importance of enabling transformational adaptation to long-term, large-scale, non-linear and uncertain changes (Abel et al. 2016; Kates et al. 2012; Thornton and Combetti 2017; Wise et al. 2014). In a way, adaptation is about staying on the current pathway of change and response, while transformation is about shifting into a different pathway or creating a new one (Folke et al. 2016).

Several binary conceptualizations have been used to describe adaptation and transformation. For example, adaptation has often been referred to as either autonomous or planned. The key difference between this dichotomy is the space where adaptation is generated, with autonomous adaptation being internally initiated by individuals within a community and planned adaptation being initiated from outside the community (e.g., Burnham and Ma 2016; Moser and Ekstrom 2010). In the case of transformation, two forms of transformation have been noted in the literature. The first is a deliberate process “initiated by the people involved”, and the second is a forced process “by changing environmental or socioeconomic conditions” (Folke et al. 2010, p. 5). Whether transformation is deliberate or forced depends on the level of transformability of the social-ecological system in question (Folke et al. 2010). Recent work has highlighted that the boundaries between these binary concepts are fuzzy, and that analytical reliance on them can be counter-productive; as with critiques to sustainability and resilience, such binary conceptualizations may mask the social processes that shape adaptive and transformative practices and strategies (e.g., Agrawal 2009; Osbahr et al. 2008).

3 Synergies, Current Debates, and Opportunities for Moving Forward

Building upon our summary of the progression of sustainability, resilience, adaptation and transformation in both the scholarly and policy domains, below we further explore the interplays between and among these key paradigms and analytical concepts. Specifically, as an interdisciplinary group of scholars, we examined recent discussions about the complex interactions between sustainability and resilience paradigms and between the concepts of adaptation and transformation, as well as the relations between adaptation/transformation and sustainability/resilience. In this section, we pay particular attention to the synergies and tensions within the literatures on human-environmental interactions, social-ecological systems and global

environmental change in order to take stock of current debates, identify practical tradeoffs that may be prohibitive towards achieving desired policy goals, and further advance the translatability of these paradigms and concepts across disciplinary and interdisciplinary fields.

Specifically, as sustainability and resilience have emerged as dominant paradigms guiding recent scholarly and policy efforts, there have been discussions and debates about whether these two paradigms are complementary or incompatible (Armitage et al. 2012; Miller et al. 2010b; Turner II 2010; Redman 2014). The extent to which systems, landscapes or communities fit within the boundaries of one or both paradigms has also become central to debates about the value and appropriate use of them. Some scholars see a clear connection between sustainability and resilience, and for them, the key question is whether and to what extent one informs or influences the other (Gonzalès and Parrott 2012; Strunz 2012). As Derissen et al. (2011), Gunderson and Holling (2002) and Leach et al. (2010) have noted, resilient systems may not necessarily be sustainable, but social-ecological systems must be resilient in order to achieve sustainability. Some authors further argue that sustainability represents a desirable human development goal and resilience thinking is the way to achieve this goal (Xu et al. 2015). As recently stated by Folke et al. (2016, p. 6), “if human well-being is a central goal of sustainability, its dependence on a resilient biosphere has to be accounted for, a necessity that has become more and more obvious.”

While some scholars continue to argue for and empirically demonstrate the use of resilience as an analytical tool to measure sustainability, others have posited that the conceptual emphases and assumptions of the two paradigms are potentially incompatible or, at least, not explicitly overlapping. For example, the resilience paradigm does not customarily address intergenerational or intragenerational equity, the former being a noted core component to achieving sustainability (Redman 2014). In this case, resilience is rejected as the championed paradigm based on conceptual and methodological inadequacies towards addressing equity, power, justice or other social concerns. Xu et al. (2015) also argue that resilience approaches are faulted for their minimal treatment of culture or cultural capital, which is sometimes integrated as a “fourth pillar” of sustainability work. On the other hand, some argue that sustainability is too diluted and unclear as a policy goal despite decades of trying to determine sustainability metrics, and they believe that resilience represents a more powerful framework for conceptualizing pressing environmental challenges and guiding policy initiatives to advance the governance of such challenges (Duit et al. 2010). However, as the resilience community continues to evolve, many have expanded the concept of resilience to be a boundary object that represents a way of thinking about the dynamics of complex systems, similar to the way sustainability has been used as a boundary object, thus losing its relative advantage over sustainability as a paradigm (Anderies et al. 2004; Brand and Jax 2007). In some contexts, sustainability and resilience have become two sides of the same coin in terms of how they have been deployed to achieve natural resource management or global environmental governance goals. Some scholars have argued that when one moves from ecological science into social science the

“meaning of resilience gets diluted and increasingly unclear” as well, because the term is used “with many different intentions” and “with a very wide extension” (Brand and Jax 2007). This further draws attention to the epistemological tensions inherent in the sustainability science and resilience thinking approaches to human-environmental problems, which remain centered on systems-based approaches, rather than adopting relational approaches commonly used within the social sciences (Cote and Nightingale 2012).

It is worth noting that most discussions about sustainability and resilience have placed a stronger emphasis on how resilience contributes to sustainability but little on how sustainability contributes to resilience. In a way, sustainability has been accepted as a policy agenda, while the debates are still ongoing about whether resilience should remain an analytical framework nested within broader sustainability science approaches or a parallel paradigm guiding future scholarly and policy endeavors (Brand and Jax 2007; Redman 2014; Xu et al. 2015). Underlying these debates is a “general agreement that we can ill afford to consider humans separately from nature,” but a disagreement on which paradigm is best suited to address challenges emerging from the coupled human and natural systems (Berkes 2004, p. 623).

We in fact urge against continued efforts to defend either paradigm as universally appropriate or applicable. Instead, we encourage further investigation of the temporal, spatial and institutional boundaries of sustainability and resilience in the context of particular systems. Such context-specific investigations will enable practitioners and policy makers to: (1) better understand how sustainability and resilience can be used as policy or programmatic goals in particular systems; (2) become more aware of the temporal, spatial and institutional considerations necessary for setting sustainability-focused or resilience-focused goals; and (3) make decisions better informed by considerations of potential tradeoffs that may occur resulting from setting sustainability or resilience goals.

Debates are also ongoing with respect to the definition, scale and scope of adaptation and transformation. Many scholars view transformation as a non-linear, abrupt adaptive response to social-ecological change, as opposed to a linear, incremental adaptive response (Dow et al. 2013; Nelson et al. 2007, Wilson et al. 2013). Some further argue that positioning transformation as an end of the adaptation spectrum creates a more conducive environment for policy makers to consider transformational change as an alternative to incremental change, rather than viewing transformation as something entirely different and beyond their reach (Pelling et al. 2015). Others have pointed out a fundamental difference in the nature of adaptation and transformation, with the former focusing on the maintenance of the function, structure, feedbacks and identity of an already existing current social-ecological system and the latter focusing on the creation of a new system altogether (Feola 2015). Because of such difference, they further argue that although some system characteristics (e.g., human capital development, social networking, and leadership) are important for enabling both adaptation and transformation, additional conditions (e.g., critical self-reflection and creative innovation) need to be met in order for transformation to occur (Apgar et al. 2015). Failure

to recognize this difference privileges incremental changes and hinders policy innovations. As such, debates about the similarities and differences between adaptation and transformation have yet to be settled. Further, it is unclear if gaining universal consensus on the relationship between adaptation and transformation would in fact contribute to the development of effective policy solutions. We argue that one way to advance adaptation and transformation research, practices and policy is to place an emphasis on documenting and analyzing when, where, why, and how each concept has been operationalized and what intended and unintended outcomes may have occurred as a result of various adaptation or transformation processes. This work can contribute to a more generalized understanding of system boundaries, components and scales often associated with successful adaptation or transformation processes as part of larger policy programs.

Beyond discussions about the sustainability-resilience and adaptation-transformation interplays, there are also fruitful intersections and possible frictions between these key paradigms and analytical concepts. Ultimately, the question has been to what extent adaptation and transformation can be situated within the sustainability and resilience paradigms (Gallopín 2006; Karpouzoglou et al. 2016). In previous theoretical and empirical research, the concept of adaptation has been operationalized mainly within the sustainability paradigm. Particularly, as adaptive governance and adaptation to change have become desired pathways to achieve goals of human well-being, scholars have pointed out the synergies between adaptation and sustainable development, and various policy initiatives have been developed to explicitly bring the two together (Burnham and Ma 2016; Eisenhauer 2016). Some even go as far joining the terms, proposing sustainable adaptability (Hernández-Delgado 2015). While the synergies between adaptation and sustainability are reassuring, the original Club of Rome report reminds us that the sustainability paradigm emerged from the perceived need for societal transformation (not adaptation) to sustain humanity at large into the future (Meadows et al. 1972).

Despite the early transformational goals of the sustainability paradigm, the concept of transformation has rarely been operationalized as a sustainable development strategy. Instead, transformation has mainly been discussed within the context of resilience, although the extent to which transformation fits within the resilience paradigm is also up for debate. While some scholars argue that transformability is an inherent and vital characteristic of resilient systems (Feola 2015; Folke et al. 2010; Walker et al. 2004), others draw sharp distinctions between transformation and resilience, which they consider a form of adaptive maintenance to sustain the existing social-ecological system (Pelling 2011; Wilson et al. 2013). The former group of scholars argue that transformation describes fundamental shifts in the existing social-ecological system, which requires the system to have “the capacity to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable” (Walker et al. 2004, p. 1). Therefore, transformation results in fundamentally different “forms of capital, diversity in landscapes and seascapes and of institutions, actor groups, and networks, learning platforms, collective action, and support from higher scales in the

governance structure” (Folke et al. 2010). As such, transformation lies beyond the domain of using single- or multi-equilibria approaches to sustain the resilience of a particular social-ecological system (Walker et al. 2004). As society increasingly faces unprecedented changes and as effective responses to these changes often require both adaptation and transformation, one might wonder if a shift away from debating the theoretical relationships between adaptation/transformation and sustainability/resilience would accentuate or attenuate policy efforts to enhance human well-being and environmental conditions (Gillard 2016). We suggest that scholarly and policy communities should move beyond considerations of which analytical concept can be better operationalized within which key paradigm, and instead focus on two empirical questions: (1) how does adaptation or transformation contribute to achieving sustainability- or resilience-focused policy or program goals? And (2) how would setting sustainability- or resilience-focused policy or program goals shape possibilities for future adaptation and transformation?

We find that the most prominent debate within the literature is an epistemological one, wherein sustainability and resilience paradigms and adaptation and transformation concepts are conceptualized differently as either descriptive or normative. While sustainability has been largely accepted as a normative paradigm, there is no consensus on whether resilience is a descriptive or normative dimension of social-ecological systems. Although resilience thinking began as early as the 1970s, resilience grew to prominence within a time when concerns were surfacing that “sustainability” had already lost its theoretical and practical cache. Whereas sustainability and sustainable development were characterized as normative from their inception, resilience was initially characterized as a descriptive concept, which was, and indeed still is promoted as a strength of the resilience paradigm (Brand and Jax 2007; Holling 1973; Walker et al. 2006). Thus, resilience, understood in a non-normative, positivistic sense, was often put advanced instead of sustainability as a policy goal. However, in recent years the descriptive legacy of resilience has been increasingly challenged and the normative nature of resilience has been increasingly recognized (Brand and Jax 2007; Brown 2014; Folke et al. 2010; Gillard 2016).

What becomes defined as resilience, or a resilient system, is too often based on implicit notions of what desirable states of systems are and who is in the position to decide what counts as desirable. Regardless of whether sustainability or resilience is applied as a policy goal in a particular system, questions of equity, power and justice follow. For both sustainable and resilient systems, it is increasingly recognized that defining system boundaries, components and desirable attributes are not value-less endeavors. These determinations are shaped by methodological tools, theoretical concerns, and disciplinary and interdisciplinary norms. Such determination is often made by outside experts—scholars, scientists, and policy makers—and rarely incorporates the paradigms, practices and concerns of local and/or indigenous residents who live their daily lives within these theorized systems on their own terms (Benessia et al. 2012; Berkes 2007; Thomas et al. 2016). More than simply a topic of scholarly debate, differing expert and local notions of the geographical and conceptual scope of relevant and desired system characteristics have

real-world implications (Johnson 2009; Johnson and Bakaaki 2016; Olsson et al. 2006; Yu et al. 2014).

Further, “as resilience travels from being a descriptive—and initially a rather precise—concept in ecology to become a normative notion in society (and policy), it becomes increasingly vague and woolly, whereas the descriptive origin somehow gets lost” (Olsson et al. 2015, p. 6). Cote and Nightingale (2012, p. 478) also point out that as resilience is adopted as a broad policy goal, it “plays an important heuristic role in shifting the focus away from the quantitative availability of resources, and towards the scope of available response options” and it “offers a dynamic and forward looking approach to human-environmental change” that places emphasis on “unpredictability, change and complexity across scales.” Some argue that the fuzziness of resilience in these contexts has hindered improvements in policy development and implementation (Davidson et al. 2016). Others, though, have been more lenient on resilience within policy, noting that, “even when ill-defined, it encourages policy makers to think deeply about ecosystems as dynamic, multiscaled and socially linked systems” (Sinclair 2016, p. 390).

This ongoing debate about the normativity of sustainability and resilience provides a possible avenue for coalescing the two paradigms. As previously discussed, applying a specified resilience framework to a system requires practitioners and policy makers to make normative decisions about enhancing the resilience of x to y for group z (Carpenter et al. 2001; Lebel et al. 2006). As such, a resilience-focused policy or program may privilege some value, output or system over others or make a system more resilient to one type of disturbances at the expense of increased vulnerability to other types of disturbances, leading to disagreements about what tradeoffs are acceptable for whom (Ingalls and Stedman 2016). In this context, focusing on resilience alone would be insufficient, and a normative decision-making framework would be necessary for helping practitioners and policy makers to engage all stakeholders and facilitate discussions and negotiations. As suggested by Anderies et al. (2013), the sustainability paradigm can meet this challenge—as a boundary object it could offer a decision-making framework that emphasizes intergenerational, intragenerational and interspecies equity and that can be used to guide decisions about tradeoffs (Domptail et al. 2013). In this way, resilience and sustainability can be complementary—sustainability over time requires specified resilience at particular points in time, and decision making about specified resilience can be guided by the normative sustainability framework.

More broadly, considering the normative dimensions of the sustainability and resilience paradigms also allows scholars, practitioners and policy makers to recognize that transformations towards more tenable and desirable systems may already be in progress in some places, for some people, rather than viewing the collapse of a particular social-ecological system as the teleological end point of systems change. This also relates to an increasing recognition of adaptation and transformation as normative rather than descriptive concepts in recent years (Hahn and Nykvist 2017; Leach et al. 2012; Pelling et al. 2015; Westley et al. 2011). As Smit et al. (1999) suggest, any effort to promote adaptation needs to first answer three questions: (1) what is being adapted to? (2) who or what adapts? (3) how does

adaptation occur? Similarly, we argue that questions such as why transformation is needed, what transformation should look like, who makes these decisions, and how the transformed system will function ought to be addressed prior to the implementation of any transformative strategies whether as part of a sustainability- or resilience-focused policy or program.

As society's needs for solving complex global problems increase, it is critical to be explicit about: (1) the descriptive criteria that can be used to measure the sustainability and resilience of a given system, and (2) the normative assumptions involved in choosing specific adaptation and transformation strategies, the trade-offs associated with implementing such strategies, and their multi-scalar implications for achieving sustainability and resilience goals. In particular, there is a need for scholars, practitioners and policy makers to reflect on the often-unstated normative assumptions and choices involved in developing and implementing policy programs so that intended outcomes are maximized and potential negative outcomes of designed adaptive and transformative changes for sustainability and/or resilience are minimized.

4 Conclusion

In the past 20 to 30 years, there have been significant advances towards better understandings of *sustainability*, *resilience*, *adaptation* and *transformation* in the scholarly literatures of human-environmental interactions, social-ecological systems, and global environmental change. In this chapter, we provided a summary of how these key paradigms and analytical concepts have evolved over time, synthesized the current debates about the interplays between and among these paradigms and concepts, charted the synergies and contradictions between and among these paradigms and concepts, discussed future directions for defining and achieving desired change, and identified the associated challenges and opportunities within both scholarly and policy domains.

Specifically, this chapter demonstrates that the debates about the compatibility between resilience and sustainability as scientific paradigms or targeted policy goals have persisted over time. Yet, many scholars, practitioners and policy makers continue to advance these paradigms as boundary objects in order to address pressing governance problems despite their “fuzziness.” Similarly, key debates around adaptation and transformation reveal different theorizations of the two concepts, with some scholars positioning both on the same continuum while others arguing that the two processes are fundamentally different (i.e., adapting to maintain existing social-ecological systems vs. transforming to create new systems). Underlying these debates is a general agreement that human well-being must be considered in conjunction with environmental conditions in the policy domain, but which paradigm or process is best suited to address challenges emerging from the coupled natural and human systems is yet to be determined (Berkes 2004).

This chapter also shows, while there is some compatibility between and among the paradigms and concepts, epistemological tensions remain prominent and formulate real concerns about the resulting tradeoffs and potential policy and program outcomes. In other words, many current debates are in fact centered around the descriptive and normative dimensions of the paradigms and concepts. One way that these epistemological tensions can be approached is by incorporating a normative sustainability framework to guide decisions about tradeoffs associated with applying a specified resilience approach towards analyses of a particular system. Ultimately, it is important for scholars, practitioners and policy makers to be explicit about not only the descriptive criteria that can be used to measure the sustainability and resilience of a given system, but also the normative assumptions involved in using specific adaptation and transformation strategies for achieving sustainability and resilience goals. As such, analyses that hone in on the normative and descriptive dimensions of policies and programs will be crucial for moving a step further towards developing transformative adaptation interventions for promoting resilient and sustainable communities—or what Bennett et al. (2016) identifies as “bright spots” of transformative change.

Finally, we argued that opportunities for moving forward with the current debates about sustainability, resilience, adaptation and transformation reside in systematic, context-specific investigations of how these paradigms and concepts have been applied in different systems, which will inform generalizations of principles and practices based on sound empirical evidence. Specifically, we saw a need for further investigating and contrasting the contexts within which sustainability and resilience have been used as policy goals, and the temporal, spatial and institutional boundaries used for setting such goals. We also saw a need for standardizing the documentation and analyses of when, where, why, and how adaptation and transformation have been operationalized and what intended and unintended outcomes may have occurred resulting from various adaptation or transformation processes. Together, these endeavors will allow the scholarly and policy communities to move beyond theoretical discussions about which analytical concepts can be better operationalized within which key paradigms and to address epistemological tensions between normative and descriptive dimensions of these paradigms and concepts. With such endeavors, the scholarly and policy communities will be able to ask questions with high policy relevance, namely how adaptation or transformation at different scales contribute to achieving sustainability or resilience goals and how setting sustainability or resilience goals shape the possibilities for future adaptation and transformation.

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