

Resilience in Environmental and Public Health: Is it Time for a Social-Ecological Systems Approach?

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Abstract

Resilience in social-ecological systems incorporates ideas about adaptability, innovation, self-organization, and the ability to persist through disturbance. It has become a concept and theory useful for analyzing and understanding social-ecological systems and the foundation for policy that is adaptive and acknowledges uncertainty. Despite the increasing popularity of social-ecological resilience in numerous disciplines, the concept has not yet been adopted within the realm of environmental and public health. This paper reviews the environmental and public health literature to describe the ways in which resilience has been used and conceptualized to date, and argues for the use of a social-ecological systems approach in environmental and public health, particularly among those sub-disciplines concerned with the impacts of environmental change on human health.

Papers and research such as this, which introduce and provide insight into the concept of social-ecological resilience aimed at an environmental and public health audience can enrich and advance strategies for protecting human health in a changing future.

Introduction

Over the past two decades, the concept of resilience in coupled social-ecological systems has gained popularity and clout across disciplines, including resource management, human dimensions of global change, and international development. Resilience in social-ecological systems incorporates ideas about adaptability, innovation, self-organization and the ability to persist through disturbance (Folke, 2006). It has become a concept and theory useful for analyzing and understanding social-ecological systems, as well as the ways in which these complex systems navigate change. Resilience in social-ecological systems has also become the foundation for policy that is adaptive in nature and acknowledges uncertainty and unpredictability. Despite these compelling qualities, the concept of social-ecological resilience has not yet been adopted within the realm of environmental and public health.

This paper is guided by the overarching question: Is it time for a social-ecological resilience approach in environmental and public health? To adequately address this question, the following paper: a) reviews resilience concepts; b) describes the ways in which resilience is used and conceptualized in environmental and public health literature; c) outlines the reasons why social-ecological resilience is a useful paradigm for environmental and public health research and practice; and d) describes the current barriers and potential bridges to greater integration of social-ecological resilience approaches in the fields of environmental and public health.

A review of this sort has not yet been conducted using a human health lens. Papers and research such as this, which introduce and provide insight into the concept of social-ecological resilience aimed at an environmental and public health audience, are needed and long overdue.

A brief history and overview of resilience

This section provides context by briefly reviewing resilience in terms of four distinct concepts that have evolved over the past 30 years: ecological resilience, engineering resilience, social resilience and social-ecological resilience (Walker et al., 2006a). Ecological resilience was first theorized and tested by the ecologist C.S. Holling in his now seminal and widely cited paper entitled ‘*Resilience and Stability of Ecological Systems*’, published in 1973. Here, resilience was developed to explain nonlinear dynamics and to describe models of change in adaptive ecological systems (Walker et al., 2006a). Holling first defined ecological resilience as ‘a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables’ (Holling, 1973; p. 14). It is important to note the difference between Holling’s definition of resilience and what is often referred to as engineering resilience, which is defined as the return rate to a steady state of equilibrium after an external disturbance (Folke et al., 2010; Pimm, 1984). The latter conceptualization of resilience ignores the possibility of multi-stable states - an important difference extensively reviewed in the ecology literature (see Holling, 1996). Holling has continued to explore and to develop resilience theory and approaches in the context of ecological systems and has more recently extended the concept towards social systems and coupled social-ecological systems. Other ecologists and scientists studying the concept of resilience have followed a similar trajectory, and resilience is now commonly applied to social systems and social-ecological systems in various fields of study and practice (Janssen et al., 2006)

In social systems, the concept has been primarily used in relation to understanding social change and is commonly defined as the ability of human communities and institutions to withstand external disturbances to their social infrastructure, such as environmental variability or political upheaval (Adger, 2000). *The Resilience Alliance* (a research network composed of scientists and social scientists from a wide array of disciplines, and founded by Holling in 1999), focuses on resilience in the context of interconnected social-ecological systems and has significantly contributed to the development of social-ecological resilience theory. Resilience in social-ecological systems has three defining characteristics: a) the amount of change the system can undergo while still retaining the same controls on function and structure; b) the degree to which the system is capable of self-organization (versus lack of organization or organization forced by external factors), and c) the ability to build and increase the capacity for learning and adaptation (Resilience Alliance, 2010; Adger et al., 2005). Accordingly, resilience is a property of complex and interconnected social-ecological systems that not only equips a system to absorb shocks and disturbances, but also enables that system to benefit from change due to the potential to create opportunity for development and innovation (Rockstrom, 2003; Adger, 2006).

Resilience in environmental and public health literature

In May 2009, Mr. Ban Ki-moon, the United Nations Secretary-General, spoke at the 62nd World Health Assembly with an address entitled ‘*Resilience and Solidarity: Our Best Response to Crisis*’. On the topic of the recent H1N1 flu pandemic and looming public health crises, Mr. Ban Ki-moon remarked on the importance of resilience and asked “*How do we build resilience in an age of unpredictability and interconnection?*” He did not, however, speak to the meaning of resilience, and it is unclear what he meant by the term. This is also the case within the realm of environmental and public health more broadly; currently very little is known about the ways

in which resilience is conceptualized and practically applied. To address this knowledge gap and to inform broader discussions about the potential role of social-ecological resilience in environmental and public health research and practice, a review of the environmental and public health literature was conducted.

Literature review methods:

A keyword-based search was conducted in ISI's Web of Science; resilience & environment were used as the keywords, and the search was limited to the subject area of public, environmental & occupational health. The initial database was reduced by considering only those publications that include 'resilience' in the abstract. The final database included 47 publications. Subsequently, abstracts were read in order to classify these 47 publications in terms of how resilience was conceptualized. Classification was based on the four concepts of resilience outlined and described by Folke (2006). For the purpose of this analysis, psychosocial resilience, which is common in the field of mental health and psychology and appears to have evolved parallel to ecological resilience, has been used in place of engineering resilience in the classification as described by Folke (2006). The characteristics, focus and context related to each of the four distinct concepts of resilience are outlined in Table 1. Finally, those publications that were classified into the social resilience group, the ecological resilience group, and the social-ecological resilience group were examined further (psychosocial resilience is not of particular interest here, but has been reviewed and explored elsewhere - see Luthar et al. (2000), Tusaie & Dyer (2004) and Rutter (2006)). The objective here is not to provide a comprehensive literature review, but rather to gain a general understanding of how resilience is used and conceptualized in environmental and public health discourse and to uncover any trends or themes relevant to broader discussions on the topic.

| Resilience concept | Characteristics | Focus on | Context |
|------------------------------|---|--|--|
| Psychosocial resilience | Positive psychological outcome and adaptation despite suffering risk | Resistance to experiences of risk | Personal attribute and/or process of coping at the individual level |
| Ecological resilience | Buffer capacity , withstand disturbance, maintenance of function | Persistence and robustness | Feature of complex and dynamic ecological system |
| Social resilience | Buffer capacity , withstand disturbance, maintenance of function | Persistence and robustness | Feature of complex and dynamic social system |
| Social-ecological resilience | Interplay between disturbances and persisting, reorganization, and developing | Adaptability, transformability, learning, innovation and feedbacks | Feature of coupled and interdependent ecological and social systems at multiple scales |

Table 1 Source: Adapted by authors from Folke (2006).

Literature review results:

After classifying and reviewing the relevant literature, it is clear that the environmental and public health literature has largely focused on the concept of psychosocial resilience (Figure 1). Fifty-five percent of the publications use resilience in terms of psychosocial resilience; a large majority of this literature focuses on child and youth as a sub-population of interest (Fitzpatrick, 1997; Eggerman & Panter-Brick, 2010; Aronowitz, 2005) or psychosocial resilience to environmental disasters (Dean & Stain, 2010; Dean & Stain, 2007). Approximately 27% of the publications use resilience in terms of social resilience and focus on resilience of social

Resilience in environmental and public health literature

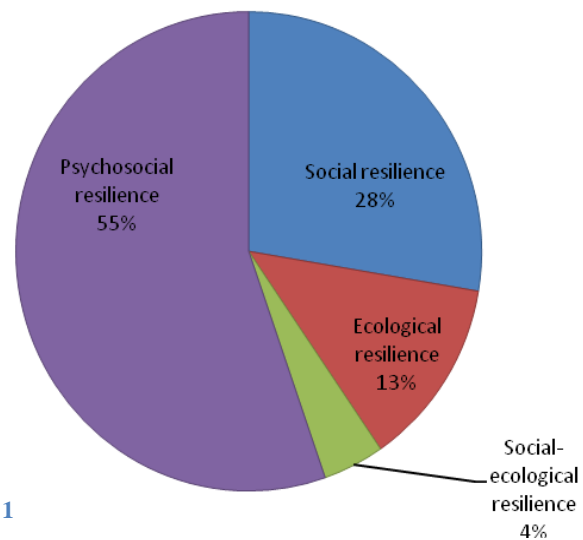


Figure 1

systems. In this group of publications, the resilience of social systems and communities to climate-related stressors and natural disasters is a common theme (Hess et al., 2008; Norris et al., 2008; Zhong & Low, 2009). Thirteen percent of the publications conceptualize resilience in terms of ecological resilience, considering resilience in terms of the persistence of ecological systems to disturbance and how this can influence human health. It is interesting to note that less than 4% of the environmental and public health literature using the concept of resilience has applied the concept in terms of coupled social-ecological resilience; this translates into only two publications (Deck et al., 2009; Parkes & Horwitz, 2009). Clearly, social-ecological resilience theory has not yet been adopted within environmental or public health research or discourse.

Looking at this literature over time, it appears that resilience surfaced in the environmental and public health literature in the late 1990s and has become more prominent only in the past four years. The concept, therefore, is relatively new and appears to be an emergent approach. Social-ecological resilience has only been identified in the literature since 2009.

Reviewing resilience in the environmental and public health literature has highlighted several interesting points. Firstly, resilience within environmental and public health literature is rarely based on systems thinking. Instead, resilience is largely conceptualized in terms of psychosocial resilience, which is primarily contextualized as a personal attribute or process of coping, and is situated at the individual level (Luthar et al., 2000; Rutter, 2006). Commonly, social or environmental factors (poverty or natural disaster, for example) are considered as external disturbances, which influence an individual's resiliency; systems-based thinking is uncommon. Systems-based resilience approaches (in terms of social, ecological or coupled social-ecological resilience) have become more frequent in recent years, suggesting this also may

be emergent. Most relevant to the discussion here is the finding that the concept of social-ecological resilience has rarely been utilized in traditional environmental and public health research or practice. This is an interesting finding as it is this concept of resilience that may in fact have the most to offer the field of environmental and public health.

Trends in the use of resilience in environmental and public health literature, 1996-2010

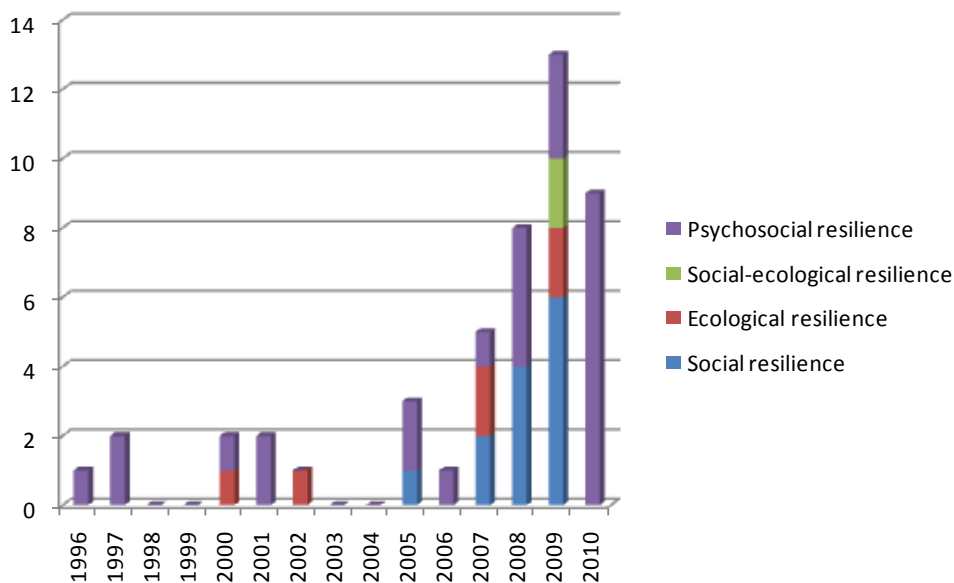


Figure 2

In support of a social-ecological resilience approach for environmental and public health research and practice

The fact that a social-ecological resilience approach is rarely used in the field of environmental and public health is somewhat surprising. Social-ecological resilience is a useful and relevant approach that should be of particular interest to those researchers and practitioners concerned with the impacts of environmental and ecosystem change on human health.

The next generation of environmental and public health researchers and practitioners will face major challenges that are triggered and mediated by ecosystem and environmental change, and that are shaped by the social systems in which they are manifest (e.g., the spread of new and drug resistant infectious diseases, food insecurity, and the health impacts of global climate change). Environmental and public health issues of this nature cannot be isolated from their context, and thus cannot be adequately understood or addressed by the traditional reductionist and linear approaches to human health, nor exclusively by social or ecological perspectives. Rather, these issues require systems thinking and a perspective that understands the interconnectedness between ecosystem functioning and dynamics, social systems, and human health outcomes. Social-ecological resilience, and perhaps the most useful expression of complex systems thinking, is as an approach that can address the current failures of environmental and public health to embed health research and practice in social-ecological realities (Parkes et al., 2008).

Policies and practical efforts that enhance resilience in social-ecological systems can, in fact, prevent negative health consequences and promote well-being in the face of disturbances such as drought, hurricanes, economic downturns, or political unrest. The most successful policies and programs will be those aimed at building community level resilience while at the same time contributing to resilience at regional (watershed or airshed) and global scales in both ecological and social systems (Folke et al., 2010). Arguably, human health will be protected and promoted in those resilient social-ecological systems characterized by an ability to maintain vital function and structure, while at the same time possessing the capacity to self-organize, adapt and, when necessary, transform in the face of disturbance. Additionally, considering that the human health impacts of environmental change and degradation disproportionately affect poor and vulnerable sub-populations, efforts that build social-ecological resilience can have positive impacts from a social justice perspective. Moreover, resilience thinking focuses on the constant change and related uncertainty and unpredictability that characterize complex dynamic systems. This, in turn, shifts the policy and practical focus away from aspirations to control change in complex systems towards enhancing the capacity of systems to cope with change, adapt to change, and learn from change (Carpenter et al., 2001). This is a fundamental paradigm shift in policy making and practice, and one that is needed to protect human health and well-being, given a future characterized by uncertainty, widespread environmental and economic disturbances, and unpredictable change (Folke et al., 2010; Rockstrom et al., 2009).

Finally, because social-ecological resilience theory has become increasingly common in a myriad of disciplines, resilience can act as a link between these disciplines to encourage and support collaboration and interdisciplinary work (Vogel, 2006). For example, scholars studying the impacts of climate change and variability on human health and well-being may use social-ecological resilience thinking as a platform to bring together and integrate various knowledge domains, enabling cross-fertilization and exchange across domains that currently tend to exist in disciplinary silos. Using resilience-based approaches and thinking in human health disciplines can encourage and support interdisciplinary work, highlight commonalities and integrate practical and policy efforts across disciplines.

The barriers and bridges: Moving towards a social-ecological system approach

Given that a social-ecological resilience approach has not yet been adopted in the field of environmental and public health to any great extent, a discussion of those factors that act as the barriers and the bridges for increased integration is warranted. Identifying the barriers and bridges is the first step in determining ways to move forward and towards the use of a social-ecological systems resilience approach within environmental and public health.

Perhaps the most prominent barrier is the continued reliance within the field on linear causality to understand human health outcomes, and reductionist rather than systems-based thinking. Despite the clear advantages of systems thinking or systemic approaches to biology and health, the dominant paradigm in health sciences is linear causal reasoning where causal risk factors are identified, and programs and policies are put in place to prevent or reduce exposure to these risk factors and thereby reduce risk of illness. This mode of thinking is not unique to health sciences, but dominates in science and culture in general.

The definitional issues surrounding the concept of resilience are another important barrier. For those scholars unfamiliar with the concept, the various ways in which the concept is defined and expressed can be extremely confusing and perhaps intimidating (Davidson, 2010). Along a

similar vein, since the current iterations of resilience in social-ecological systems and research in the field have developed outside traditional human health arenas, these definitions are not readily available to researchers and practitioners in environmental and public health.

Progress can, however, be discerned and there are several forces that may act as bridges to facilitate the application of social-ecological theory and thinking in environmental and public health. For example, a great deal can be learned by examining the progress that has been made in the field of ecology with regards to resilience in ecosystems. Although some caution must be taken when making analytical moves and analogies from ecological to social systems or from ecological to social-ecological systems, there are several important lessons that can be learned from the past 30 years of research and theoretical development in ecology (Adger, 2000).

Additionally, efforts by scholars and practitioners in other disciplines in which social-ecological resilience has taken root are beginning to work towards the creation of scholarly networks and new funding bodies that incorporate and consider human health (see, for example, the September 2010 special feature issue of *Ecology and Society* entitled ‘*Risk Mapping for Avian Influenza: A Social-Ecological Problem*’).

Finally, the concept of resilience is closely linked to both vulnerability and adaptation. Although the exact nature of the relationship is contested in the literature, it is clear that the two concepts are closely related (Adger, 2006; Cutter et al., 2008). Environmental and public health are fundamentally concerned with vulnerabilities, again for the most part at the individual level and increasingly at the population level, but rarely at the systems level (deFur et al., 2007). Climate change science is currently grounded in efforts towards identifying vulnerabilities and options for adaptation. Drawing links between current vulnerability and adaptation approaches in environmental and public health and social-ecological resilience can highlight the potential utility of a resilience-based approach. However, in order to move ahead with social-ecological system resilience, particularly in relation to the impacts of climate change on human health, more work is needed that considers the similarities and differences between vulnerabilities, adaptation and social-ecological resilience as well as the utility of these concepts and approaches in various contexts and health related issues.

Conclusion

It is important to appreciate that social-ecological resilience is an evolving concept (Rockstrom, 2003). The key features of resilient systems, the ways to operationalize them, and measure resilience quantitatively, are currently debated in the literature across disciplines. More research, both quantitative and qualitative in nature, and in diverse settings, will be essential to the continued advancement of social-ecological resilience (see Walker et al. (2006b) for many research questions related to social-ecological system resilience that remain unanswered to date). Of particular relevance to the field of public health is research that identifies how to measure and monitor resilience, and how to determine the pathways to build resiliency in complex social-ecological systems. Furthermore, conceptual frameworks, adapted from those frameworks used in other disciplines, but tailored to environmental and public health issues, are called for.

Generally speaking, advances in the theories and frameworks that tackle the complex socio-ecological realities that influence human health and well-being and work towards enhancing system-wide capacity to deal with and learn from change and disturbances are needed in environmental and public health to adequately prepare for the challenging issues of the future.

The concept of resilience is rooted in ecology and has developed over the past three decades into a theory that considers the complexities of ecological and social systems and, most recently, coupled social-ecological systems. The concept of resilience, in terms of social or ecological resilience, appears to be emerging in the field, but social-ecological resilience is, to date, rarely used in environmental and public health. This paper has outlined the reasons why social-ecological resilience is both relevant and useful for environmental public health. To come full circle and return to the original question posed at the outset of this paper, it is time for a social-ecological resilience approach in environmental public health research and practice.

References:

- Adger, W. N. (2000). Social and ecological resilience: are they related? *Progress in Human Geography*, 24(3), 347-364.
- Adger, W. N., Hughes, T. P., Folke, C., Carpenter, S., and Rockström, J. (2005) Social-ecological resilience to coastal disasters. *Science*, 309, 1036-1039.
- Adger, W. N. (2006). Vulnerability. *Global Environmental Change-Human and Policy Dimensions*, 16(3), 268-281.
- Aronowitz, T. (2005).The role of "envisioning the future" in the development of resilience among at-risk youth. *Public Health Nursing*, 22(3), 200-208.
- Carpenter, S., Walker, B., Anderies, J. M., & Abel, N. (2001). From metaphor to measurement: Resilience of what to what? *Ecosystems*, 4(8), 765-781.
- Cutter, S. L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., Webb, J. (2008). A place-based model for understanding community resilience to natural disasters. *Global Environmental Change-Human and Policy Dimensions*, 18(4), 598-606.
- Davidson, D. J. (2010). The applicability of the concept of resilience to social systems: Some sources of optimism and nagging doubts. *Society & Natural Resources*, 23(12), 1135-1149.
- Dean, J. G., & Stain, H. J. (2007).The impact of drought on the emotional well-being of children and adolescents in rural and remote New South Wales. *Journal of Rural Health*, 23(4), 356-364.
- Dean, J. G., & Stain, H. J. (2010). Mental health impact for adolescents living with prolonged drought. *Australian Journal of Rural Health*, 18(1), 32-37.
- Deck, O., Verdel, T. & Salmon, R. (2009).Vulnerability assessment of mining subsidence hazards. *Risk Analysis*, 29(10), 1381-1394.
- deFur, P. L., Evans, G., Cohen Hubal, E., Kyle, A., Morello-Frosch, R., Williams, D. (2007). Vulnerability as a function of individual and group resources in cumulative risk assessment. *Environmental Health Perspectives*, 115(5), 817-824.
- Eggerman, M. & Panter-Brick, C. (2010). Suffering, hope, and entrapment: Resilience and cultural values in Afghanistan. *Social Science & Medicine*, 71(1), 71-83.
- Fitzpatrick, K. M. (1997). Fighting among America's youth: A risk and protective factors approach. *Journal of Health and Social Behavior*, 38(2), 131-148.

- Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change-Human and Policy Dimensions*, 16(3), 253-267.
- Folke, C., Carpenter, S.R., Walker, B., Scheffer, M., Chapin, T., & J. Rockström, J. (2010). Resilience thinking: integrating resilience, adaptability and transformability. *Ecology and Society*, 15(4), 20.
- Holling, C. S. 1973. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, 4, 1-23.
- Holling, C. S. (1996). Engineering resilience versus ecological resilience. In Schulze, P. (ed). *Engineering within ecological constraints*. National Academy Press, Washington, D.C. pp. 31-44.
- Hess, J. J., Malilay, J. N., & Parkinson, A. J. (2008). Climate change: The importance of place. *American Journal of Preventive Medicine*, 35(5), 468-478.
- Janssen, M.A., Schoon, M.L., Ke, W., Børrner, K., 2006. Scholarly networks on resilience, vulnerability and adaptation within the human dimensions of global environmental change. *Global Environmental Change*, 16 (3), 240–252.
- Luthar, S. S., Cicchetti, D., & Becker, B. (2000). The construct of resilience: A critical evaluation and guidelines for future work. *Child Development*, 71(3), 543-562.
- Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology*, 41(1-2), 127-150.
- Parkes, M.W., Morrison, K, Bunch, M., and Venema, H. (2008). Ecohealth and watersheds: Ecosystem approaches to re-integrate water resource management with health and well-being. Network for Ecosystem Sustainability and Health and the International Institute for Sustainable Development, Winnipeg, MB.
- Parkes, M. W., & Horwitz, P. (2009). Water, ecology and health: ecosystems as settings for promoting health and sustainability. *Health Promotion International*, 24(1), 94-102.
- Pimm, S.L. (1984). The complexity and stability of ecosystems. *Nature*, 307, 321- 326.
- Resilience Alliance (2010). Resilience. URL: <http://www.resalliance.org/>. Accessed, December 5, 2010.
- Rockstrom, J. (2003). Resilience building and water demand management for drought mitigation. *Physics and Chemistry of the Earth*, 28(20-27), 869-877.
- Rockstrom, J., Steffen, W., Noone, K., Persson, A., Chapin, F. S., Lambin, E. F., Lenton, T.M. (2009). A safe operating space for humanity. *Nature*, 461(7263), 472-475.

- Rutter, M. (2006). Implications of resilience concepts for scientific understanding. In B. M. Lester, A. S. Masten & B. McEwen (Eds.), *Resilience in Children*, 1094, 1-12.
- Tusaie, K., & Dyer J. (2004). Resilience: A historical review of the construct. *Holistic Nursing Practice*, 18(1), 3-10.
- Vogel, C. (2006). Foreword: Resilience, vulnerability and adaptation: A cross-cutting theme of the international human dimensions programme on global environmental change. *Global Environmental Change-Human and Policy Dimensions*, 16(3), 235-236.
- Walker, B. H., J. M. Anderies, A. P. Kinzig, and P. Ryan. (2006a). Exploring resilience in social-ecological systems through comparative studies and theory development: introduction to the special issue. *Ecology and Society*, 11(1), 12.
- Walker, B., Gunderson, L., Kinzig, A., Folke, C., Carpenter, S., & Schultz, L. (2006b). A handful of heuristics and some propositions for understanding resilience in social-ecological systems. *Ecology and Society*, 11(1), 13.
- Zhong, Y., & Low, S. P. (2009). Managing crisis response communication in construction projects - from a complexity perspective. *Disaster Prevention and Management*, 18(3), 270-282.